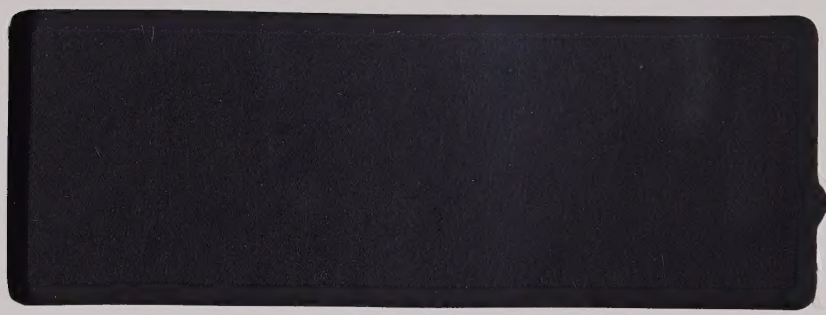
INSTRUCTION MANUAL

DIGITAL MULTIMETER

550 ACCESSORY MODULES

B/CS

RACAL-DANA



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5200 SERIES*

DIGITAL MULTIMETER

550 ACCESSORY MODULES

B/CS

*Model 5233 is covered in Sections 7, 8, and 9

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RACAL

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WARRANTY

Within one year of purchase, Racal-Dana will repair or replace your instrument, at our option, if in any way it is defective in material or workmanship. The instrument must be returned to the country of purchase, unless prior arrangement has been made, and Racal-Dana Instruments will pay all parts and labor charges. Just call Racal-Dana Product Service at (714) 859-8999 in U.S.A., Windsor (07535) 69811 in England, (3) 955-8888 in France, 06102-2861/2 in Germany or (02) 6459558/6468189 in Italy for assistance. We will advise you of the proper shipping address for your prepaid shipment. Your instrument will be returned to you freight prepaid.

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FOR YOUR SAFETY

Before undertaking any maintenance procedure, whether it be a specific troubleshooting or maintenance procedure described herein or an exploratory procedure aimed at determining whether there has been a malfunction, read the applicable section of this manual and note carefully the WARNING and CAUTION notices contained therein.

The equipment described in this manual contains voltage hazardous to human life and safety and which is capable of inflicting personal injury. The cautionary and warning notes are included in this manual to alert operator and maintenance personnel to the electrical hazards and thus prevent personal injury and damage to equipment.

If this instrument is to be powered from the AC line (mains) through an autotransformer (such as a Variac or equivalent) ensure that the common connector is connected to the neutral (earthed pole) of the power supply.

Before operating the unit ensure that the protective conductor (green wire) is connected to the ground (earth) protective conductor of the power outlet. Do not defeat the protective feature of the third protective conductor in the power cord by using a two conductor extension cord or a three-prong/two-prong adaptor.

Maintenance and calibration procedures contained in this manual sometimes call for operation of the unit with power applied and protective covers removed. Read the procedures carefully and heed Warnings to avoid "live" circuit points to ensure your personal safety.

Before operating this instrument:

1. Ensure that the instrument is configured to operate on the voltage available at the power source. See Installation Section.

2. Ensure that the proper fuse is in place in the instrument for the power source on which the instrument is to be operated.

3. Ensure that all other devices connected to or in proximity to this instrument are properly grounded or connected to the protective third-wire earth ground.

If at any time the instrument:

- Fails to operate satisfactorily
- Shows visible damage
- Has been stored under unfavorable conditions
- Has sustained stress

It should not be used until its performance has been checked by qualified personnel.

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Figure 1.1 5230 and 5270 Digital Multimeter

SECTION 1

INTRODUCTION

1.1 INTRODUCTION

1.2 This manual describes the Dana Series 5200 Digital Multimeters (DMM). The basic models are the 5230 and the 5270 which differ only in their mechanical packaging. Model 5230 is a thin-line instrument (3 ½ inches high) designed for standard rack mounting while Model 5270 is primarily a bench type instrument (see figure 1.1). Descriptions in this manual apply to all models unless otherwise indicated.

1.3 MECHANICAL DESCRIPTION

1.4 Each instrument consists of three modules. The Digitizing and Display Module, comprising the left-hand portion of Model 5230 and the upper half of Model 5270 contains the actual measurement circuits and is the same in all instruments in the series. The Signal Conditioning Module, comprising the right-hand side of Model 5230 and the lower half of Model 5270 contains circuits that provide a ten-volt full-scale analog voltage for measurement by the Digitizing and Display Module. The Power Supply Module, located at the rear of the instrument, provides all the DC voltages needed by the machine and serves as an interconnection board for all other modules. The BCD Output Module (optional) plugs into the rear of the instrument and provides 1-2-4-8 coded BCD for use in data systems.

1.5 This Manual covers Accessory Module 550 which provides measurement of DC voltages on full scale ranges of 1 volt to 1000 volts. AC voltage on full scale ranges of 1 volt to 1000 volts, and ohms on full scale range of 1 Kilohm to 10 Megohm are available as options. The combination of modules produce two DMM models designated as 5230 550 and 5270-550

1.6 The Digitizing and Display circuits are on a single printed circuit board. The signal conditioning unit consists of an isolator board and an optional Ohms-AC Converter Board. Circuits consist of integrated circuits except for critical analog circuitry where discrete components are used.

1.7 The output is displayed on a five-digit visual display with a sixth overrange digit that extends full-scale of each range by 20% (99999 to 120000). Automatic ranging is performed by internal circuits which determine the optimum range and switch to that range automatically.

1.8 ELECTRICAL DESCRIPTION

1.9 A block diagram of the DMM is shown in figure 1.2. For DC measurements, the input is applied to a voltage divider which divides the input voltage by 1 or by 100 depending on the range selected. The scaled input is filtered and applied to the Isolator amplifier which delivers 10 volts full scale (12 volts, with overrange) to the Digitizing and Display module. The gain of the amplifier is either 1 or 10 depending on the range.

1.10 For AC measurements, the AC Converter scales the input and rectifies it. The converter output is applied to the voltage divider (set to divide by one), filtered, then applied to the isolator amplifier, set to a gain of 10.

1.11 For Ohms measurement, the Ohms Converter monitors the output of the isolator to provide a constant current to the input terminals. The amount of current is dependent on the range selected. The DMM measures the voltage drop across the unknown resistance connected between the input terminals. The input voltage is applied to

the voltage divider (set to divide by one) and then applied to the isolator amplifier, set to a gain of 10. (A detailed analysis of the Signal Conditioning Module is given in Section 4A).

1.12 The Digitizing and Display module measures the analog voltage from the Accessory Module by the high-accuracy dual-slope integration technique. The amplitude of the signal is measured by comparing it to a highly stable internal reference voltage. The DMM readout displays the contents of a counter which measures the time required for the integrator voltage to change from the level of the input signal to zero. The value displayed is equal to the voltage level of the input. A new reading is taken every 300 milliseconds with the OFF-ON-HOLD switch in the ON position. The HOLD position permits the instrument to remain at the last reading indefinitely. Reading accuracy of the DMM is maintained through the use of a highly stable, zener-regulated, internal reference voltage.

1.13 SPECIFICATIONS

1.14 Specifications are listed in table 1.1.

Table 1.1 Specifications

DC (5200/550)	
Full Scale Ranges:	±1.19999, ±11.9999, ±119.999, and ±1199.99 volts
Resolution:	10 μV
Ranging:	Automatic or manual
Accuracy:*	
24 hours, ±1°C	±0.005% of reading ±0.002% of full scale
90 days, ±1°C	±0.01% of reading ±0.002% of full scale
Temperature Coefficient:	
0 to 50°C	±0.001% of reading ±0.003% of full scale/°C
Input Resistance:	
1 V range	100 megohms
10 V range	1000 megohms
100 and 1000 V ranges	10 megohms
Normal Mode Noise Rejection:	
At 60 Hz	97 dB
59 Hz to 100 kHz	60 dB minimum plus an additional 37 dB at each multiple of 10 Hz
Filter Characteristics	3 pole active
Common Mode Noise Rejection:	
Up to 1 kilohm in either lead	
DC to 61 Hz	120 dB minimum
Settling Time:	
to 0.01% of final value	650 ms
Maximum Voltage Rating:	
any range	1000 volts

*Add .001% of reading per 100 volts input signal

Table 1.1 Specifications (Continued)

AC (With addition of Model 01 AC Converter or Model 03 AC/Ohms Converter)	
Full Scale Ranges:	1.19999, 11.9999, 119.999, 1199.99 V rms
Resolution:	10 μV
Ranging:	Automatic or manual
Accuracy: 90 days, ±5°C	
50 Hz to 100 Hz	±0.25% of reading ±0.10% of full scale
100 Hz to 5 kHz	±0.10% of reading ±0.02% of full scale
5 kHz to 20 kHz	±0.50% of reading ±0.05% of full scale
20 kHz to 100 kHz	±2.00% of reading ±0.10% of full scale
Input Resistance:	
1 V range	2 megohms
All other ranges	1 megohm
Common Mode Noise Rejection:	
Up to 1000 ohms in either lead	
DC to 61 Hz	60 dB
Settling Time:	
to 0.1% of final value	2 seconds
Maximum Voltage Rating:	
50 Hz to 100 kHz	500 V to 10 kHz decreasing linearly to 100 V rms at 100 kHz
Shunt Capacitance:	With front input only 150 pF maximum With parallel rear input, 300 pF maximum

DC/DC RATIO (With addition of Option 04)	
Full Scale Ranges:	+.119999:1, +1.19999:1, +11.9999:1, and +119.999:1
Ranging:	Automatic or manual
Accuracy:	
90 days, ±1°C	±0.03% of reading ±0.003% (10 V/reference) of full scale

Table 1.1 Specifications (Continued)

	Input Signal (Numerator)	*Reference Signal (Denominator)*
Voltage Range:	0 to +1000 V	+2 to +12 V
Input Resistance:		
.1:1 range	100 megohms	10 kilohms
1:1 range	1000 megohms	10 kilohms
10:1 and 100:1 ranges	10 megohms	10 kilohms
Normal Mode Noise Rejection, Common Mode Noise Rejection, and Settling Time:	Same as DC specifications	

KILOHMS (With addition of Model 02 Ohms Converter or Model 03 AC/Ohms Converter)	
Full Scale Ranges:	1.19999, 11.9999, 119.999, 1199.99, and 11999.9 kilohms
Resolution:	10 milliohms
Ranging:	Automatic or manual
Accuracy: 90 days, ±5°C	
1, 10, 100 kilohm ranges	±0.02% of reading ±0.003% of full scale
1000 kilohm range	±0.04% of reading ±0.003% of full scale
10,000 kilohm range	±0.25% of reading ±0.003% of full scale
Normal Mode Noise Rejection:	
At 60 Hz	40 dB minimum
Settling Time: to 0.01% of final value	
1, 10, 100 kilohm ranges	.5 sec
1000 kilohm range	1.5 sec
10,000 kilohm range	3.0 sec
Current Through Unknown:	
1 kilohm range	1 milliampere
10 kilohm range	100 microamperes
100 kilohm range	10 microamperes
1000 kilohm range	1 microampere
10,000 kilohm range	.1 microampere

Table 1.1 Specifications (Continued)

Fault Voltage:	
1 kilohm range	30 volts peak
10 kilohm range	100 volts peak
100, 1000, and 10,000 kilohm ranges	300 volts peak

GENERAL	
Digitizing Technique:	Dual Slope Integrator
Integration Time:	100 ms
Maximum Common Mode Voltage:	250 volts
Maximum Power Requirements:	25 watts, 105 to 125 volts, 50 to 400 Hz
Operating Temperature:	0 to 50°C
Warm Up:	½ hour
Dimensions:	
Model 5230	17 x 3½ x 14 inches
Model 5270	8½ x 7 x 14 inches
Weight (approximate)	15 pounds net, 20 pounds shipping
Guarantee	12 months, faulty workmanship or component failure

SECTION 2

INSTALLATION

2.1 UNPACKING AND INSPECTION

2.2 The 5200 series DMM is sandwiched between two forms of plastic foam and packed in a double-walled cardboard carton for shipment. The plastic forms hold the DMM securely in the carton and absorb any reasonable external shock normally encountered in transit. Prior to unpacking, examine the exterior of the shipping carton for any signs of damage. Carefully remove the DMM from the carton and inspect the exterior of the instrument for any signs of damage. If damage is found, notify the carrier immediately.

2.3 The 5200 series DMM, as shipped, is designed for bench-top operation. A standup bracket is provided under the case to aid in reading the visual display. The Model 5230 instrument can be adapted for rack installation with two flange mounting holes located in each of the two side panels. The rack-mounting kit (Dana 402588) is attached to the instrument by removing and discarding the four set screws occupying the mounting screw holes and securing the two rack mounting flanges to the side panels of the instrument with the four screws contained in the rack mounting kit.

2.4 The Model 5270 can be ordered from the factory as a half-rack instrument or the standard instrument can be returned to the factory for modification to accommodate the half-rack mounting hardware.

2.5 POWER CONNECTIONS

2.6 A standard eight-foot, three-wire, power cable is supplied with the instrument. This cord connects to a three-pin power connector at the rear of the unit.

2.7 INPUT CONNECTIONS

2.8 Signal input binding posts are located on the front of the accessory module. Connections to these terminals are made with standard "banana" plugs. Instruments designated by a "dash 1" (-1) following the model number are equipped with a duplicate set of input binding posts on the rear panel of the instrument.

2.9 INITIAL CHECKOUT PROCEDURES

2.10 The following procedure is performed to verify that no damage has occurred during shipment and that the instrument is operative. Slight deviations in readings during the following tests may be corrected by making simple adjustments. For instructions refer to Section 5, "Calibration". Any major discrepancies should be reported to the carrier and to Dana Laboratories immediately.

2.11 Prior to performing the checkout procedure, it is advisable to refer to the operating instructions beginning with paragraph 3.2. Allow one-half hour for instrument to warm up before proceeding.

2.12 ZERO CHECK

(a) Select DC and auto range.

(b) Short input leads. Visual readout should display .00000.

(c) If necessary, adjust ZERO OFFSET control on front panel to obtain this reading.

2.13 POLARITY AND GAIN CHECK

(a) Select DC and 10 range.

(b) Apply a known voltage of approximately -10 volts to the input. Visual readout should display value of input voltage (within specified tolerance) and proper polarity.

2.14 RANGE CHECK

(a) Select DC and 100 range.

(b) Connect input to a source of +100 volts.

(c) Visual readout should display input value (within specified tolerance) and proper polarity.

(d) Vary input voltage and polarity; check for proper readout.

(e) Repeat the above four steps on 1000-volt range.

(f) Select Auto range and repeat the above checks.

2.15 AC CHECK (optional)

(a) Select AC and connect signal generator to input. Set generator to 400 Hz.

(b) Check for proper readout (within specified tolerance) with each of the following input voltages applied: 9 volts, 90 volts and 125 volts.

2.16 KILOHMS CHECK (optional)

(a) Select Kilohms

(b) Check for proper readout (within specified tolerance) with each of the following resistances connected across the DMM input: 1K, 10K, 100K, 1 Meg, and 10 Megohm.

NOTE

If the DMM has been stored for a prolonged period (5 or 6 months), without use, it is recommended that it be operated with a variable transformer, such as a Variac, at one-half line voltage for about two hours before gradually applying full power. This is done to "reform" the electrolytic capacitors in the amplifier and reduce the chance of capacitor failure.

2.17 SPECIFICATION VERIFICATION

2.18 General. This procedure is designed to ensure that the instrument is operating properly and within its specifications. If any of the readings are not within tolerance refer to the calibration procedure

2.19 Preparation. The DMM requires a minimum of thirty minutes warmup time. The initial positions of the front panel controls and the Ratio X10 pushbutton switch, located on the rear panel, are given in table 2.1. Unless stated otherwise in the procedure, the controls should be left in the position shown. Unless otherwise stated, the GUARD terminal should always be strapped to the low input terminal. Following the warmup period, check the DMM zero by placing a short clip lead across the HIGH and LOW input terminals and adjusting the ZERO OFFSET control on the front panel for a reading of .00000 with the polarity indicating +. It is important that the clip lead have plain unplated copper clips. Cadmium plated clips act like thermocouples, generating enough potential to produce several digits of zeroing error in some cases.

2.20 Equipment. A list of required equipment is given in table 2.2.

2.21 Procedure. Connect the DMM and the required test equipment as shown in the figure supplied with each accuracy check. Select the controls and input as called out in the tables and monitor the DMM readout for the indicated values.

Table 2.1

DMM CONTROL	INITIAL SETTING
Function	DC
Range	Auto
Off-On-Hold	On
Ratio X10 (rear)	Out (If so equipped)

TABLE 2.2

REQUIRED EQUIPMENT

TYPE	REQUIRED SPECS	SUGGESTED EQUIPMENT
DC Voltage Standard	Adjustable: 0–1000V Resolution: 1 uV on 10V range Accuracy: ±.003%	Fluke Model 332A or Cohu Model 351
Decade Voltage Divider	Adjustable from 0 through 9 in each of the 6 decades. Input resistance: 10,000 ohms, minimum Output resistance: 5000 ohms, maximum. Accuracy .005% or better.	ESI – Decavider Model RV-622A
AC Laboratory power source	Variable: 0 to 500V RMS & 20 Hz to 100 kHZ. Resolution better than 100 PPM. Harmonic distortion of 0.1% or less. Stability of .01%	Optimation Type AC 110 (oscillator matching transformer & power amplifier)

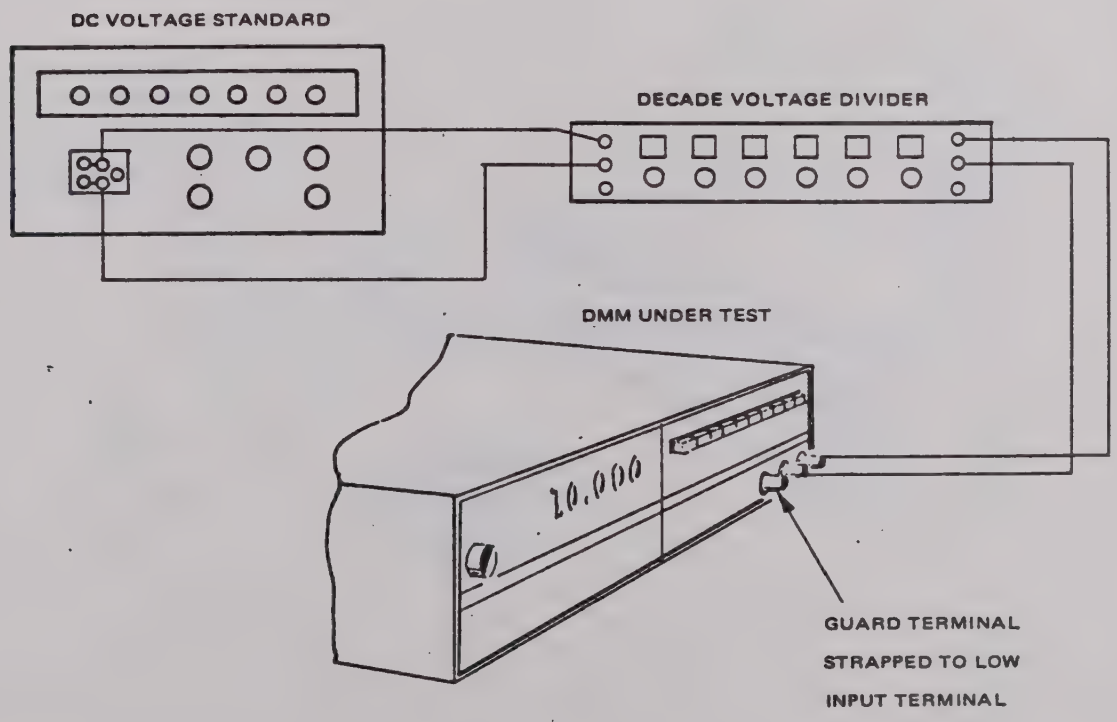
Table 2.2

REQUIRED EQUIPMENT (Continued)

Thermal Transfer voltmeter	AC/DC thermal transfer voltmeter. Ranges: 1 to 500V. Accuracy 0.05% or better.	Holt Model 6 Thermal Transfer Voltmeter
Standard Resistors	1K, 10K, 100K, and 1 and 10 Megohm. All ±.005% except 10 Meg. which is ±.01%	ESI SR-1 series standard resistors.
½ W Carbon Resistor	1,000 ohms ±10%	
½ W Carbon Resistor	10,000 ohms ±10%	
Capacitor	1uF, 100 V or more	
Capacitor	100pf ±1% 100V or more	
Batteries, 2 required	1.5V cells having screw type binding posts	

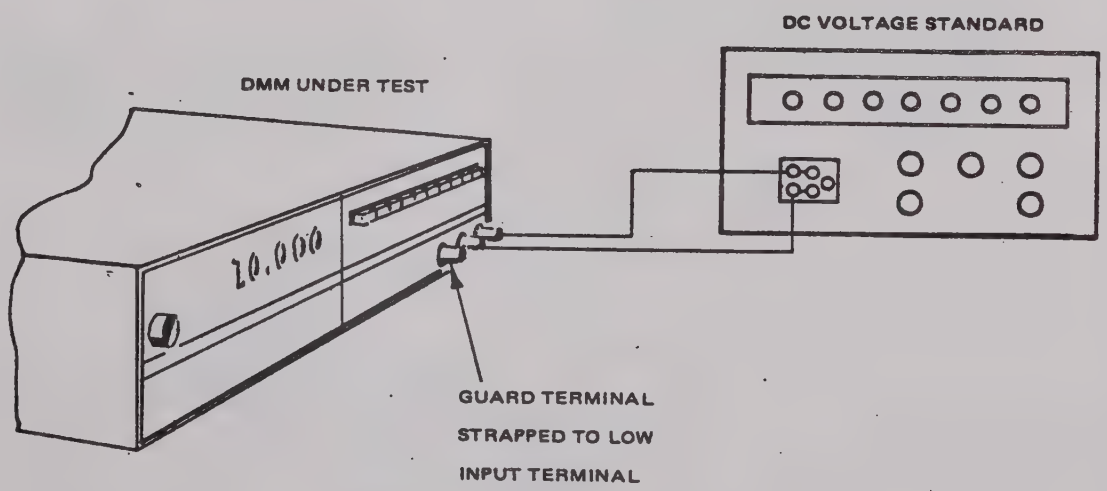
DC RANGE CHECK (Low Ranges)

DMM		INPUT SIGNAL		NOMINAL READING	TOLERANCE	NOTE
FUNCTION	RANGE	DC VOLTAGE STANDARD	DIVIDER SETTING			
DC	1	10.00000V	.100000	1.00000	.99988 –1.00012	ROOM TEMP. 23° +1° C
	10	10.0000V	1.000000	10.0000V	9.9988 –10.0012	



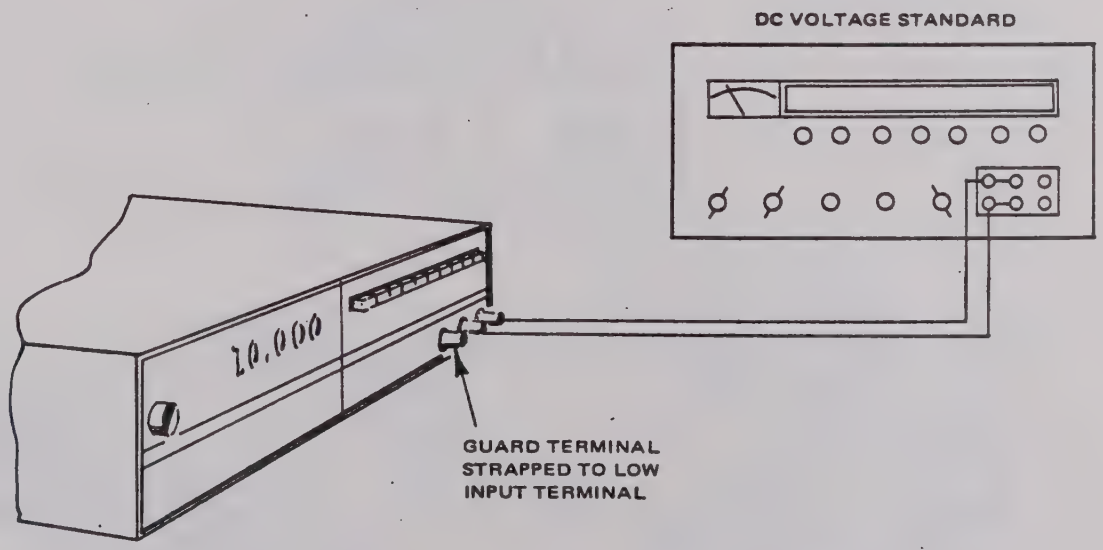
DC RANGE CHECK (High Ranges)

DMM		INPUT SIGNAL		NOMINAL READING	TOLERANCE	NOTE
FUNCTION	RANGE	DC VOLTAGE STANDARD				
DC	10	10.0000V		10.0000	9.9988-10.0012	ROOM TEMP. 23° +1° C
	100	100.000V		100.000	99.988-100.012	
	1000	1000.00V		10000.00	999.88-1000.12	



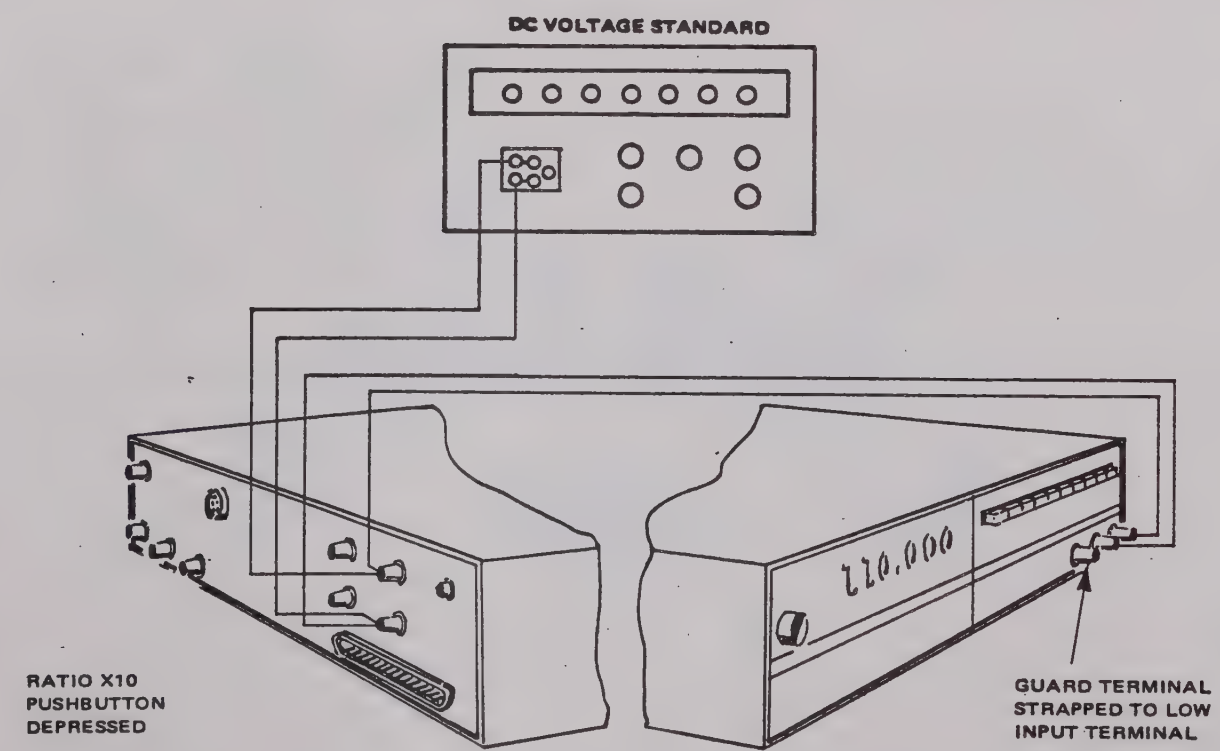
DC LINEARITY CHECK

DMM		INPUT SIGNAL		NOMINAL READING	TOLERANCE	NOTE
FUNCTION	RANGE	DC VOLTAGE STANDARD				
DC	100	90.0000V		90.000	89.998 - 90.002	1 digit of error was added when the % of reading specification is ½ digit or greater. DC voltage tolerance not included in tolerance specification
		80.0000V		80.000	79.998 - 80.002	
		70.0000V		70.000	69.998 - 70.002	
		60.0000V		60.000	59.998 - 60.002	
		50.0000V		50.000	49.998 - 50.002	
		40.0000V		40.000	39.998 - 40.002	
		30.0000V		30.000	29.998 - 30.002	
		20.0000V		20.000	19.998 - 20.002	



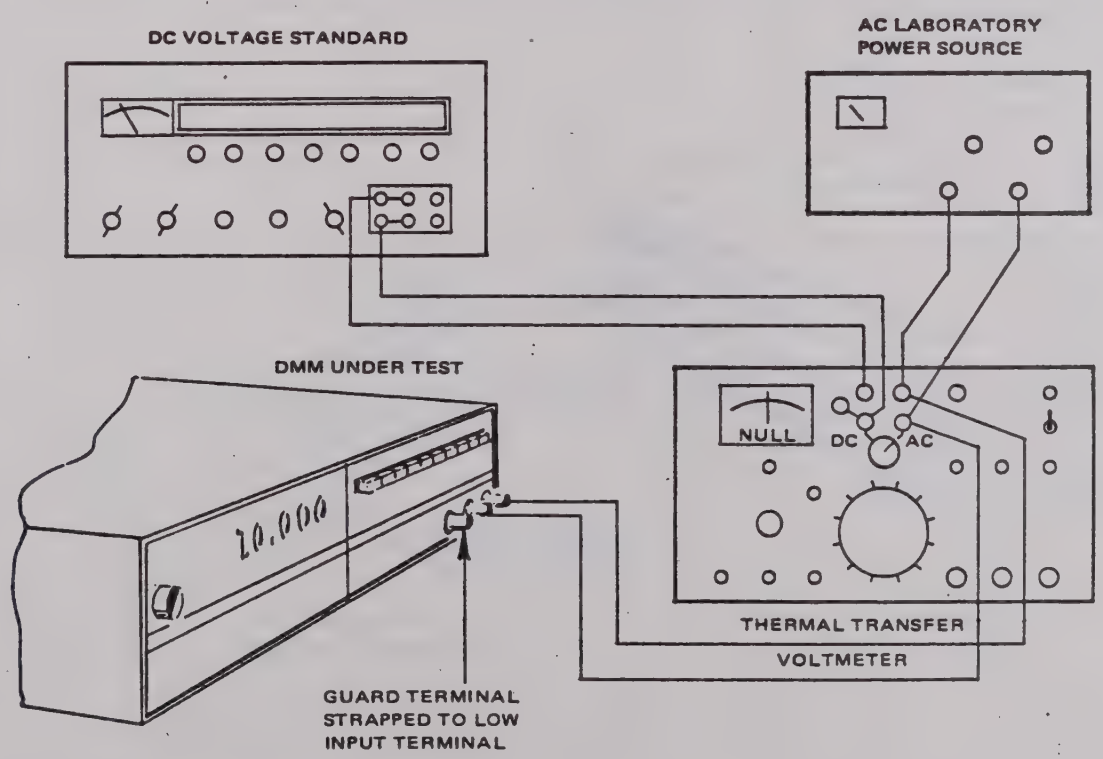
RATIO CHECK

DMM		INPUT SIGNAL		NOMINAL READING	TOLERANCE	NOTE
FUNCTION	RANGE	DC VOLTAGE STANDARD				
DC	10	2.00000		10.0000	9.9955-10.0045	
Ratio X10 Pushbutton on rear panel is depressed.	10	10.00000		10.0000	9.9966-10.0033	



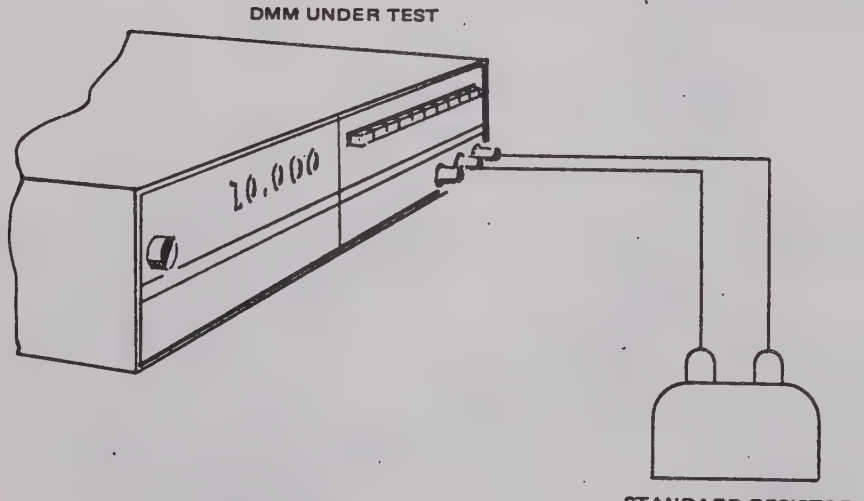
AC RANGE CHECK

DMM		INPUT SIGNAL		NOMINAL READING	TOLERANCE	NOTE
FUNCTION	RANGE	DC VOLTAGE STANDARD	AC			
AC	1	1.000000	1V 50 Hz	1.00000	.99650 - 1.00350	Set the thermal transfer voltmeter to the same range as the DMM Adjust the amplitude controls on the AC source to null the AC against the DC standard on the thermal transfer voltmeter's null meter. (for each new setting) Room temp. 23° ± 5°C
		1.000000	1V 400 Hz	1.00000	.99880 - 1.00120	
		1.000000	1V 50 kHz	1.00000	.97900 - 1.02100	
	10	10.00000	10V 50 Hz	10.0000	9.9650 - 10.0350	
		10.00000	10V 400 Hz	10.0000	9.9880 - 10.0120	
		10.00000	10V 50 kHz	10.0000	9.7900 - 10.2100	
	100	100.0000	100V 50 Hz	100.000	99.650 - 100.350	
		100.0000	100V400Hz	100.000	99.880 - 100.120	
		100.0000	100V50kHz	100.000	97.900 - 102.100	
	1000	500.000	500V 50 Hz	500.00	498.20 - 501.80	
		500.000	500V400Hz	500.00	499.30 - 500.70	
		125.0000	125V50kHz	125.00	121.00 - 129.00	



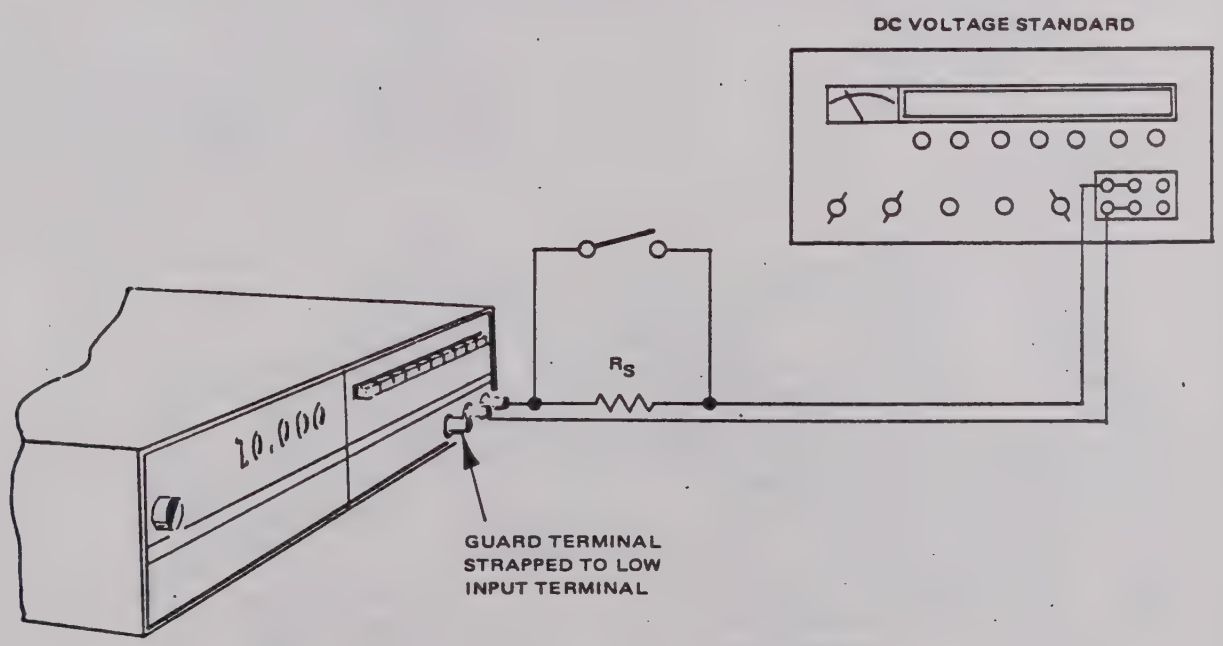
KOHMS RANGE CHECK

DMM		RESISTANCE INPUT		NOMINAL READING	TOLERANCE	NOTE
FUNCTION	RANGE	VALUE	TOLERANCE			
Kohms	1	1 Kohm	± .0005%	1.00000	.99977 - 1.00023	Allow for the resistance of the test leads.
	10	10 Kohm	± .0005%	10.0000	9.9977 - 10.0023	
	100	100 Kohm	± .0005%	100.000	99.977 - 100.023	
	1000	1 Megohm	± .0005%	1000.00	999.57 - 1000.43	Room temp. 23°C ± 5°C
	10,000	10 Megohm	± .001%	10000.0	9974.6 - 10,0253	



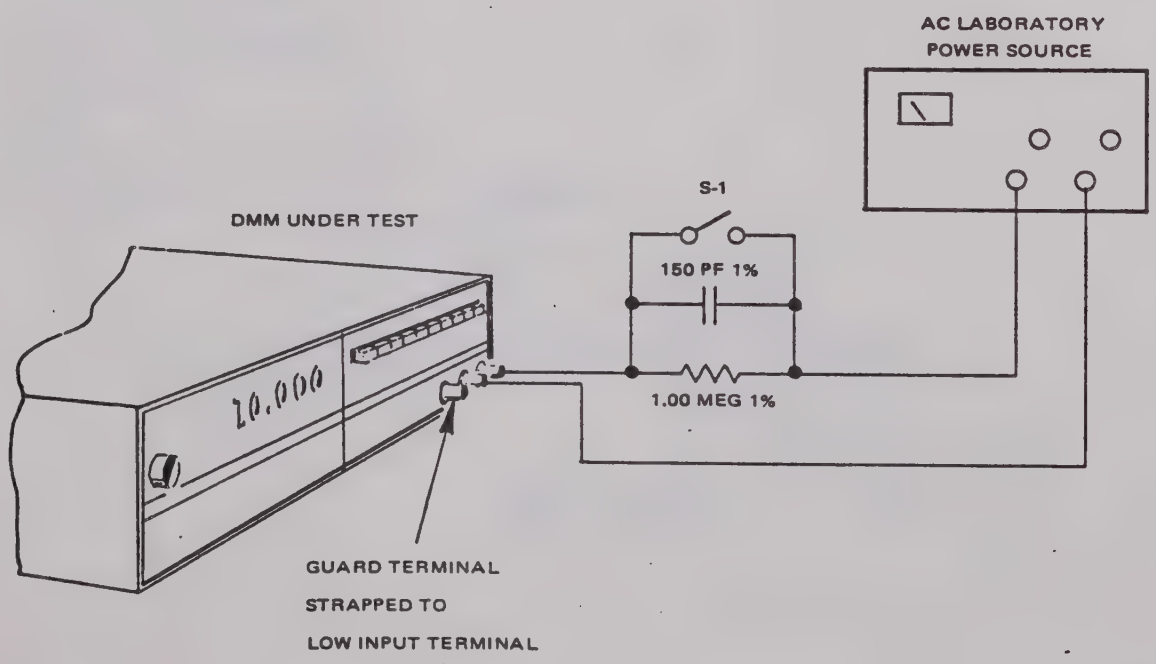
DC INPUT RESISTANCE

DMM		INPUT SIGNAL		NOMINAL DISPLAY (f.s. reading)	TOLERANCE	Rs
FUNCTION	RANGE	DC VOLTS	S-1			
DC	1	1.00000	Closed	1.00000	f.s reading ± 1 digit	100 Kohm ±.005
			Open		f.s reading ± 1 digit	
	10	10.0000	Closed	10.0000	f.s. reading ± 1 digit	1Megohm ± .005
			Open		f.s. reading ± 1 digit	
	100	100.000	Closed	100.000	f.s. reading ± 1 digit	10 Kohm ± .005
			Open		f.s. reading ± 1 digit	
	1000	1000.00	Closed	1000.00	f.s. reading ± 1 digit	10 Kohm ± .005
			Open		f.s. reading ± 1 digit	



AC INPUT IMPEDANCE: Low Frequency

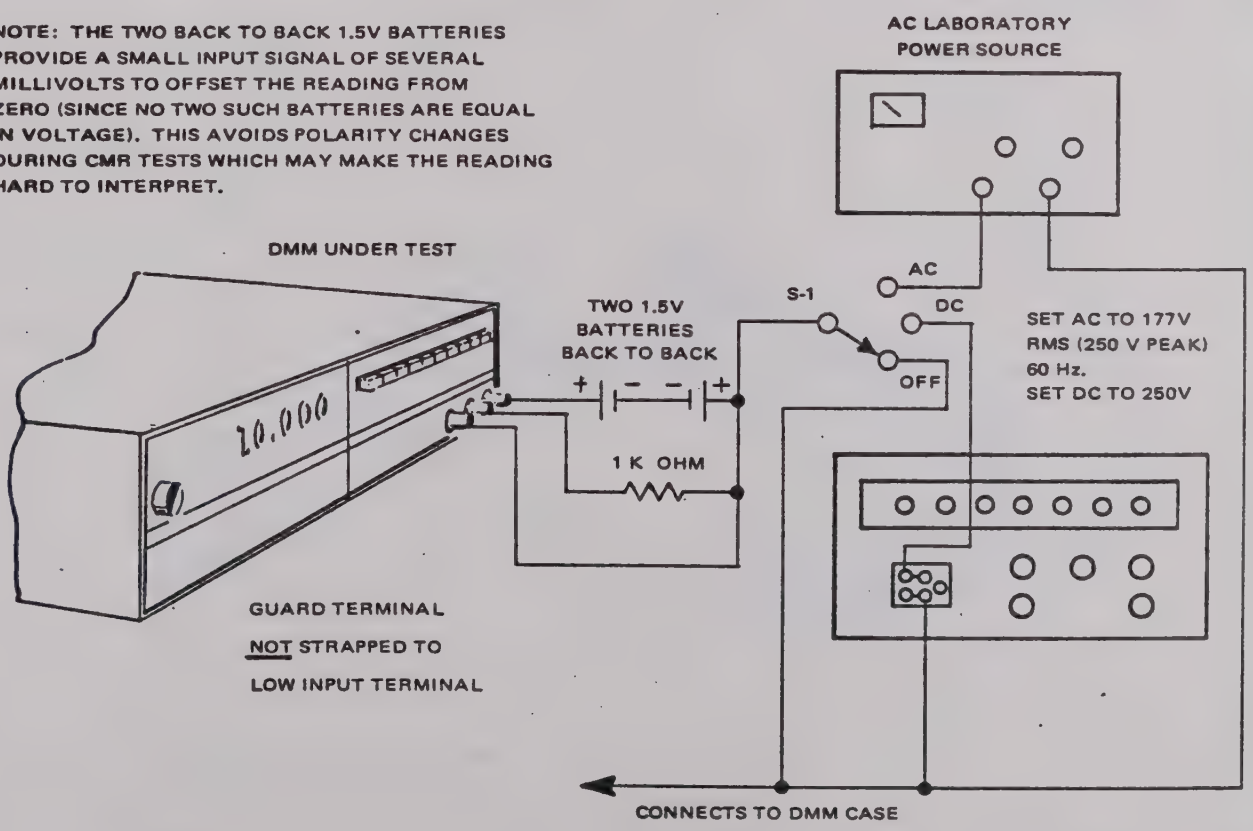
DMM		INPUT SIGNAL		NOMINAL READING	TOLERANCE	NOTE
FUNCTION	RANGE	AC SOURCE	S-1			
AC	10	10V 400Hz*	Closed	10.000*	10.000 exactly*	*Adjust AC source for a reading of 10.000V on DMM with S-1 closed. For models without rear input option 550-1
		10V 400Hz*	Open	05.000	05.000	
AC	10	10V 50kHz*	Closed	10.000*	10.000	
		10V 50kHz*	Open	05.000	05.000	



COMMON MODE REJECTION (In DC Volts Function)

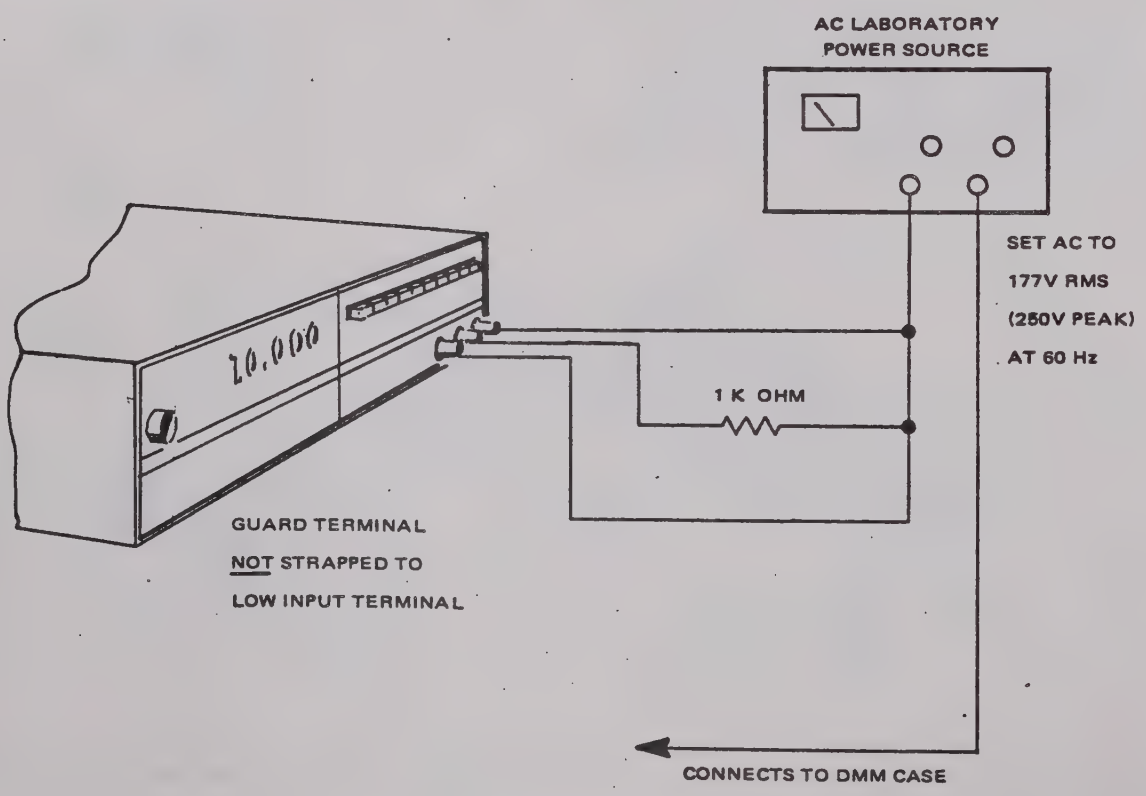
DMM		INPUT SIGNAL		NOMINAL READING	TOLERANCE	NOTE
FUNCTION	RANGE	S-1		See Note 1		
DCV	1	Off				1) With switch S-1 in the off position, record the reading displayed on the DMM's readout in the "nominal reading" boxes of the table. ± 25 digits = 120 dB
	1	DC			± 25 digits from nominal	
		AC			± 25 digits from nominal	

NOTE: THE TWO BACK TO BACK 1.5V BATTERIES PROVIDE A SMALL INPUT SIGNAL OF SEVERAL MILLIVOLTS TO OFFSET THE READING FROM ZERO (SINCE NO TWO SUCH BATTERIES ARE EQUAL IN VOLTAGE). THIS AVOIDS POLARITY CHANGES DURING CMR TESTS WHICH MAY MAKE THE READING HARD TO INTERPRET.



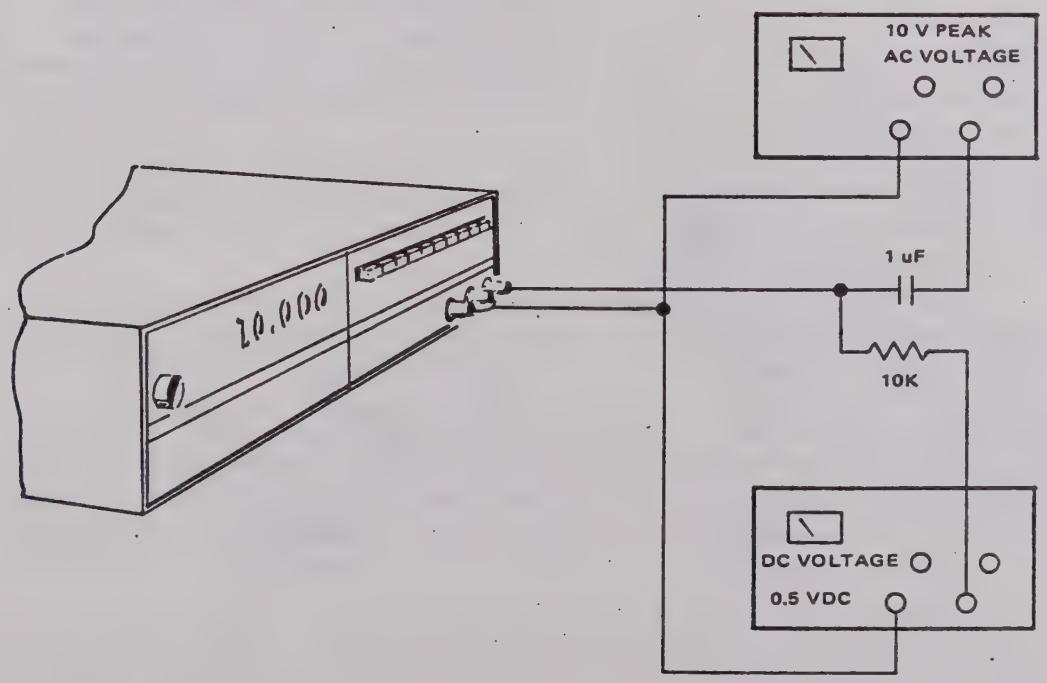
COMMON MODE REJECTION (In AC Volts Function)

DMM		COMMON MODE INPUT SIGNAL		NOMINAL READING	TOLERANCE	NOTE
FUNCTION	RANGE	VOLTAGE	FREQ.			
AC	1	177V RMS	60 Hz	.17800	.17800	
	10	177V RMS	60 Hz	.1780	.1780	
	100	177V RMS	60 Hz	.178	.178	



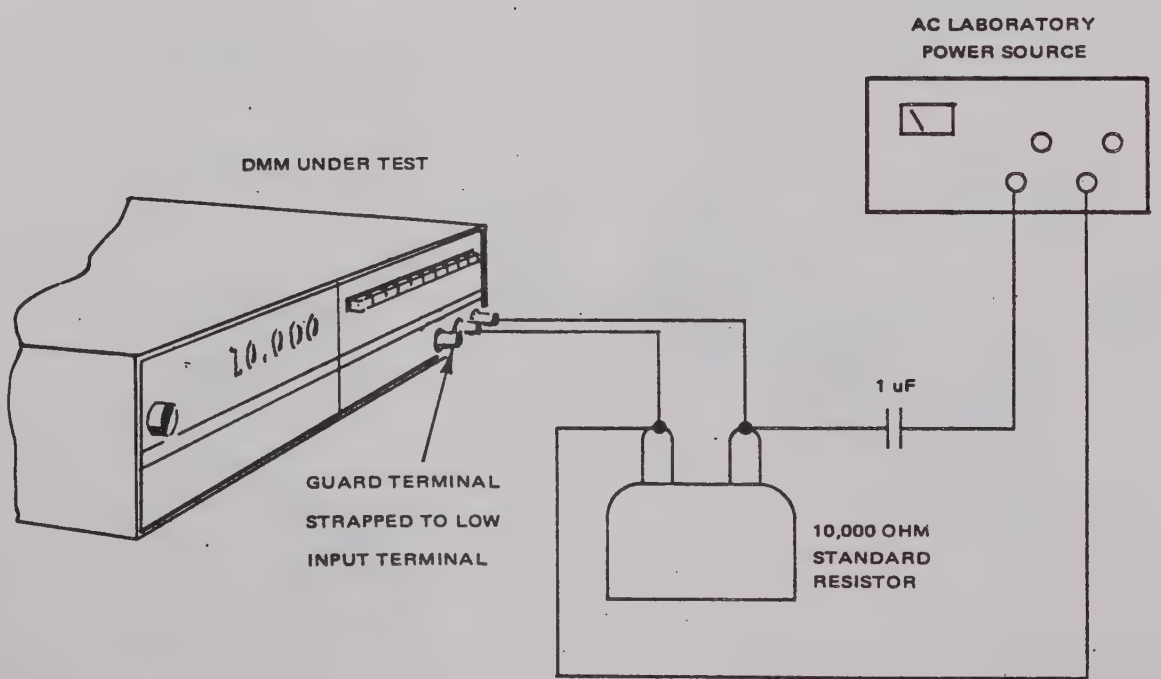
NORMAL MODE NOISE REJECTION (In DC Volts Function)

DMM		INPUT SIGNAL		NOMINAL READING	TOLERANCE	NOTE
FUNCTION	RANGE	DC	AC			
DC	10	0.5V		0.5000	± 2 digits	
		0.5V	10VP 59Hz	0.5000	± 102 digits	
		0.5V	10VP 60Hz	0.5000	± 3 digits	
		0.5V	10VP100kHz	0.5000	± 2 digits	



NORMAL MODE NOISE REJECTION (In Kohms Function)

DMM		INPUT SIGNAL		NOMINAL READING	TOLERANCE	NOTE
FUNCTION	RANGE	RESISTOR	AC			
Kohms	10	10 Kohms	1V 60 Hz	10.000	± 120 digits	



SECTION 3
OPERATION

3.1 CONTROLS

3.2 OFF-ON-HOLD SWITCH. The three position switch controls power to the instrument and allows the selection of HOLD.

(a) OFF - all power is removed from the instrument.

(b) ON - the instrument is operating and taking readings at 3.3 per second.

(c) HOLD - "freezes" the last reading of the instrument until it is switched back to the ON position.

3.3 All controls on the Model 550 Module, with the exception of the screwdriver-adjusted ZERO control, are pushbutton switches, located on the front panel. *If the instrument is not equipped for optional functions (AC or Kilohms), the switches corresponding are disabled.*

3.4 AC SELECT. This switch selects the measurement of AC voltages from 50 to 100 kHz on the 1, 10, 100 and 1000 volt range.

3.5 KILOHMS SELECT. This switch selects the measurement of resistance with full scale ranges of 1K, 10K, 100K, 1 Meg and 10 Megohms.

3.6 DC SELECT. This switch selects DC measurements with full scale ranges from 1.0 volt to 1000 volts. The three function select switches are interlocked to allow the selection of only one function at a time.

3.7 RANGE CONTROL. The range control consists of six interlocking pushbutton switches: 1, 10, 100, 1000, 10,000 and AUTO.

(a) Manual ranges. Ranges are selected by depressing the appropriate switch. The switches are interlocked so that as one range switch is depressed, the previously selected range switch is returned to the open position.

(b) Auto range. This mode allows the DMM to select the range that provides the highest accuracy for the signal being measured. This switch is interlocked with the other five range switches.

3.8 ZERO ADJUST. To zero the DMM, short the two input leads together, select DC and autorange. Adjust the ZERO OFFSET potentiometer for a DMM readout display of .00000.

3.9 OPERATION

3.10 GENERAL. The instrument has been designed for the simplest possible level of operation. Once the instrument has been connected to the power line and to the signal source in accordance with the instructions, the operator can make all the required measurements by setting the front panel controls to the indicated positions.

CAUTION: Voltage applied between guard and the low-input terminal must not exceed 250 volts (peak). Voltage applied between guard and the instrument case (power line ground) must not exceed 500 volts (peak). Voltage applied between the low-input terminal and the instrument case must not exceed 500 volts (peak).

3.11 DC MEASUREMENTS. Attach the high side of the signal source to the white signal input terminal, the low side to the black signal input

terminal. In most operations the guard terminal is jumpered to the Black Signal Input Terminal. This applies to DC, AC and Ohms Measurements.

3.12 AC MEASUREMENTS.(optional). Attach the high side of the signal source to the white signal input terminal, the low side to the black input terminal.

3.13 OHMS MEASUREMENT (optional). Connect the resistance to be measured between the white and black signal input terminals.

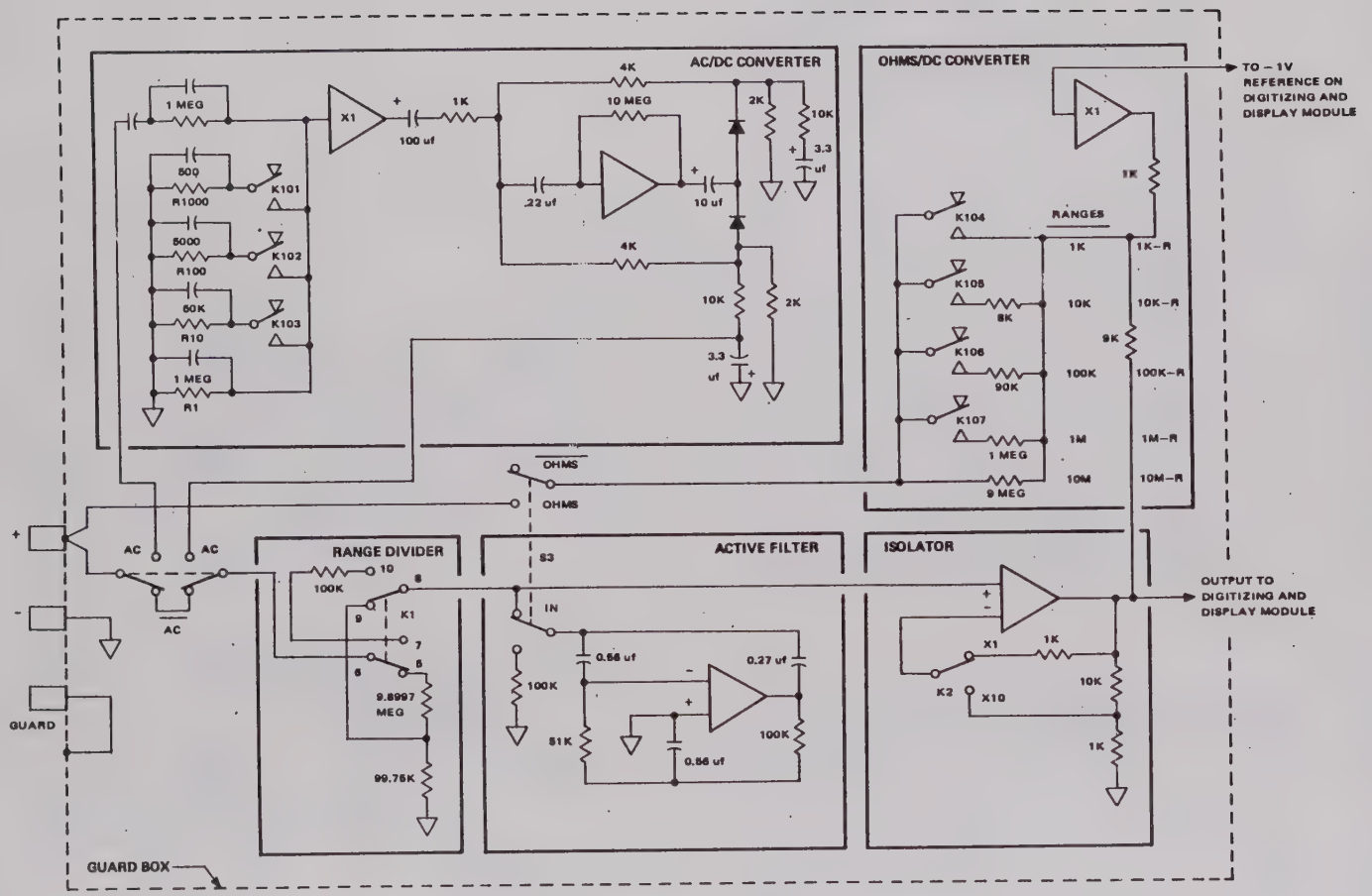


Figure 4A.1 - Simplified Diagram - Accessory Module 550

SECTION 4A

THEORY OF OPERATION OF THE SIGNAL CONDITIONING MODULE

4A.1 INTRODUCTION

4A.2 The Signal Conditioning Module provides a 10-volt full-scale (12 volts with overrange) analog signal for measurement by the Digitizing and Display Module. The Isolator, range logic circuits and active filter are located on the main board. The AC and Ohms Converters are located on an optional second board which is mounted directly above the isolator board in the module. The output signal from the module may be either a positive or negative voltage when the unit is operating in the DC volts function. Polarity sensing is done in the Digitizing and Display Module. Section 4A assumes the unit to be fully equipped with both AC and Ohms options. For instruments not fully equipped, disregard the appropriate section(s).

4A.3 INPUT CIRCUITRY

4A.4 As an input signal enters the DMM it first encounters the pushbutton switches which select the function. If the DMM is set to the AC VOLTS function, (AC Pushbutton depressed) the input signal is routed directly to the AC/DC converter. If the DMM is not in the AC VOLTS function, (AC Pushbutton not depressed) the signal is routed to the RANGE DIVIDER. The Range Divider is a single 100:1 voltage divider consisting of a 9.8997 megohm and a 99.75K ohm precision resistor. It is switched into the circuit only in the DC VOLTS function and then only on the 100 and

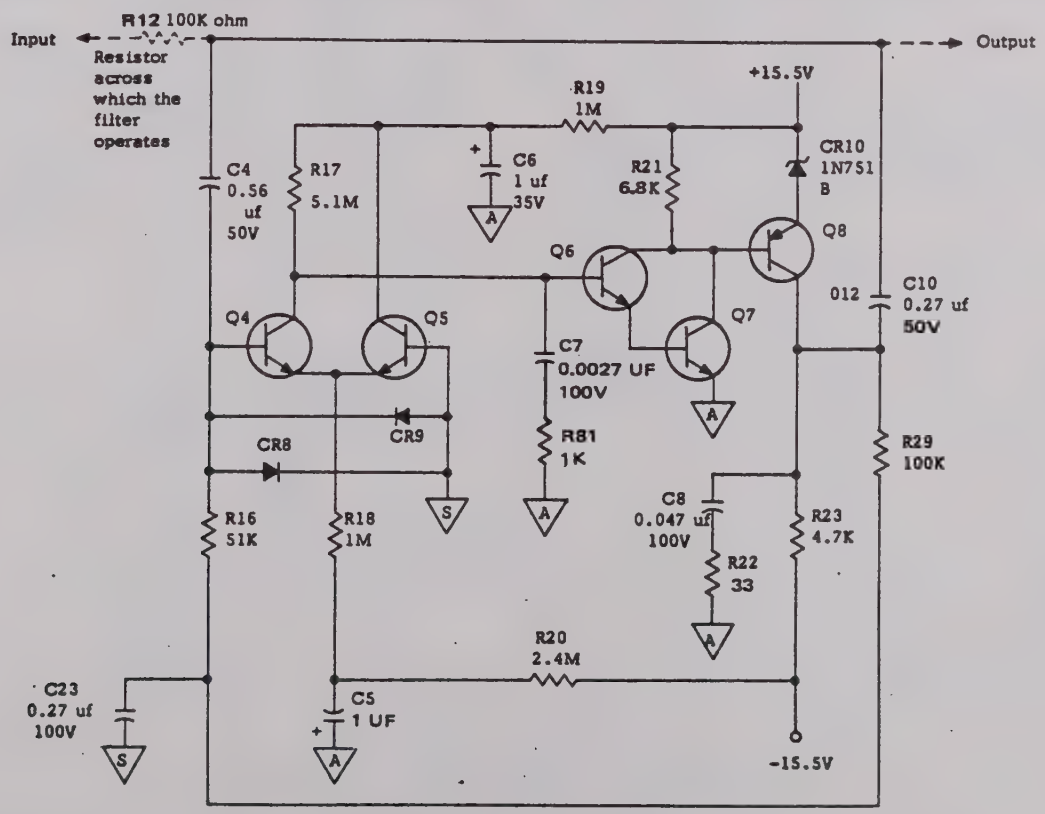


Figure 4A.2A - Active Filter

1000 volts ranges. A full scale output of 10 volts from the Isolator is achieved for all ranges by changing the gain of the Isolator amplifier and/or switching in the Range Divider. The input circuitry and Range Divider are shown in figure 4A.1.

4A.5 ACTIVE FILTER

4A.6 The filter (figure 4A.2) is a three-pole RC active filter used in both AC and DC measurements. The circuit, a modified gaussian filter, provides a normal mode noise rejection of 60 dB at 60 Hz increasing 18 dB per octave to 80 dB.

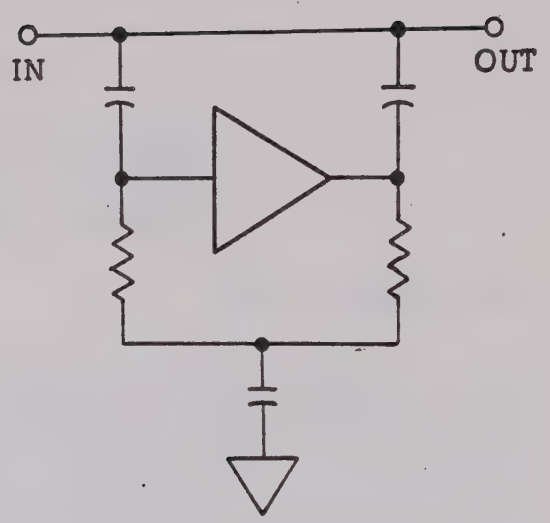


Figure 4A.2B - Active Filter Block Diagram

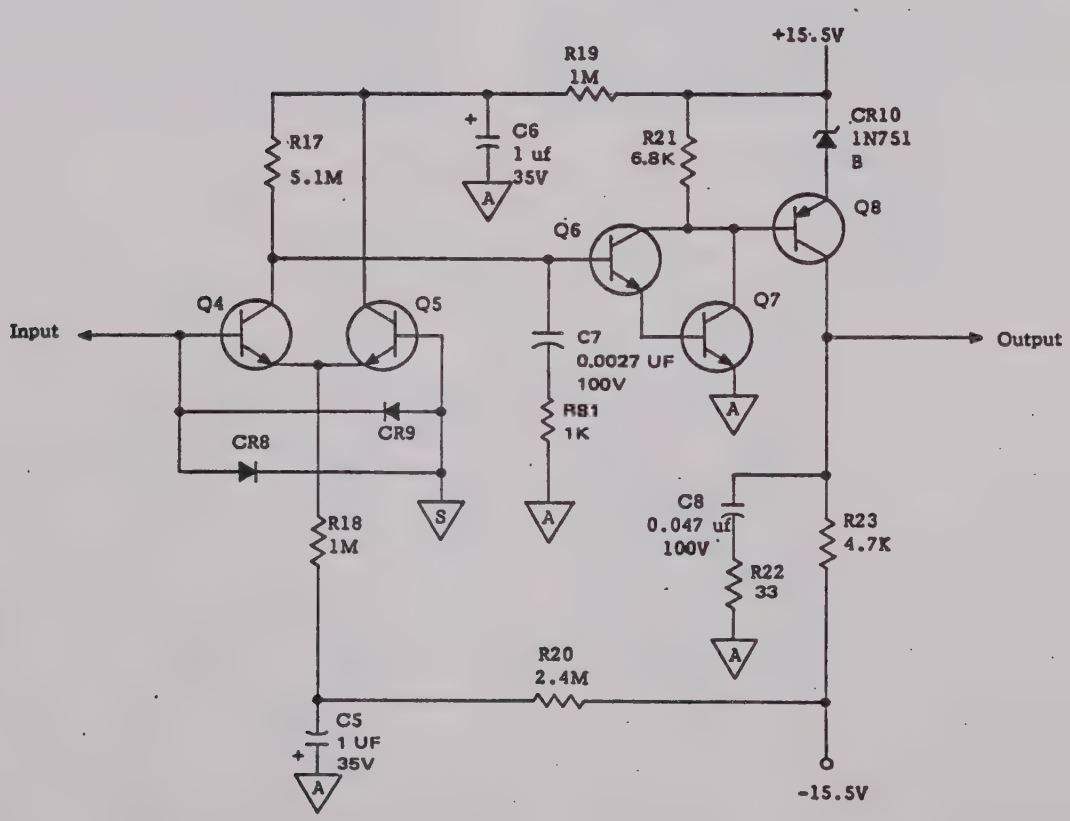


Figure 4A.3 - Active Filter DC Amplifier

4A.7 FILTER OPERATIONAL AMPLIFIER

4A.8 The active element is a DC amplifier. The feedback network around this DC amplifier is so connected that the circuit forms an operational amplifier with resistors R16 and R29 and capacitor C23 forming the feedback path. Capacitor C4 acts as the summing resistor (reactance).

4A.9 The DC amplifier (figure 4A.3) is a differential input amplifier having a single-ended output. The amplifier is connected between positive and negative voltage supplies, enabling its output to swing both positive and negative from zero. The first stage of the amplifier is a long-tailed pair composed of transistors Q4 and Q5. Only a single-ended output is taken from the input pair. This is taken from the collector of transistor Q4 which is the only one of the two input transistors provided with a collector load resistor. The second stage of the amplifier consists of the Darlington—connected pair of transistors Q6 and Q7. Resistor R21 provides the collector load for this stage. The output stage of the amplifier is composed of transistor Q8 with resistor R23 as its collector load. Zener diode CR10 in the emitter circuit of Q8 biases the emitter of Q8 5 volts away from the positive power supply yet provides a low dynamic impedance to AC signals. Diodes CR8 and CR9 across the bases of the input stage clamp the input voltage and never allow it to exceed ± 0.6V.

4A.10 ISOLATOR

4A.11 The Isolators output varies from zero to ± 11.9999-volt full scale analog voltage. This is applied to the Digitizing and Display Module for measurement. The Isolator amplifier operates at a gain of one or ten depending on the range and function to which the DMM is set. Refer to table 4A.1. The gain is switched by relay K2 which controls the resistive divider in the feedback circuit of the Isolator amplifier.

4A.12 A close examination of the isolator circuitry (figure 4A.4) reveals that it consists of two completely separate amplifiers, one that processes the signal and one that serves to bootstrap the signal and one that serves to bootstrap the power supply feeding the front stages of the main amplifier. This is shown more clearly in figure 4A.5. The output stage, shown in its entirety in figure 4A.5, is a conventional complementary—symmetry type circuit which operates between the regular positive and negative supplies. The output stage is driven by transistor Q23, which also operates off the main plus and minus voltage sources.

4A.13 Refer to figure 4A.4. Transistors Q15 and Q16 form positive and negative current generators which operate off the main positive and negative supply lines. Such current generators exhibit a

Range	Logic	F/S Isolator Input	Isolator Gain	Relay Position	
				K1	K2
1	R1 $\overline{R2}$ $\overline{R3}$	1V	10	Open	Open
10	$\overline{R1}$ R2 $\overline{R3}$	10V	1	Open	Closed
100	R1 R2 $\overline{R3}$	1V	10	Closed	Open
1000	$\overline{R1}$ $\overline{R2}$ R3	10V	1	Closed	Closed
10000	R1 $\overline{R2}$ R3	1V	10	Closed	Open

Table 4A.1 - Range Logic

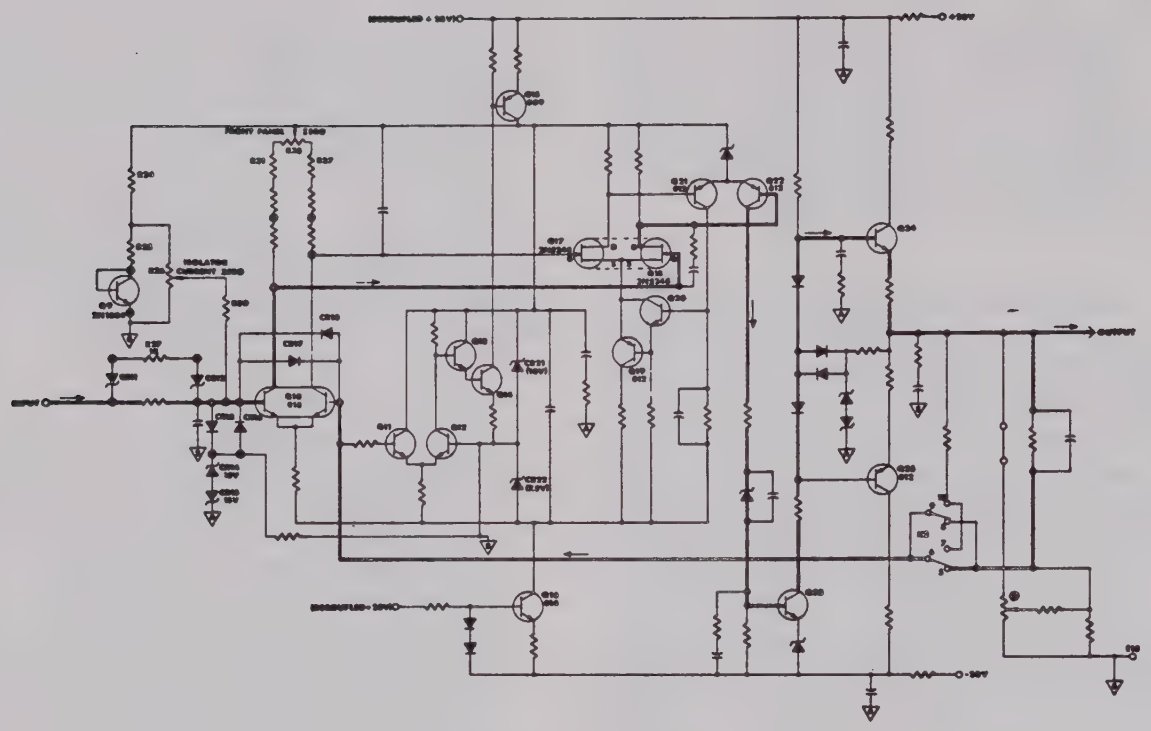


Figure 4A.4 - Isolator

characteristically high output impedance while providing a known and controlled flow of current through Zener diodes CR21 and CR22. This is shown clearly in figure 4A.5. If the node where zener diodes CR21 and CR22 join together were grounded, as is the case in most conventional zener type supplies, the zeners would always deliver positive 10V and negative 7.5V to the forward stages of the amplifier. This node, however, is not grounded but is connected to the output of the bootstrap amplifier. The bootstrap amplifier is a unity gain amplifier whose input is connected to the inverting input of the first stage of the isolator amplifier. The neutral point of the zener supplies is thus driven by the bootstrap amplifier and is always at a voltage potential equal to that at the input of the bootstrap amplifier.

4A.14 Inherent in the operation of high-gain closed loop feedback amplifiers such as the Isolator amplifier is the principle that the error signal or potential difference across its inputs (inverting and non-inverting input bases) is always very small and can in most practical cases be ignored. This being the case, it can be seen that the voltage at the inverting input to the Isolator (and hence at the input to the bootstrap amplifier) is always equal to the input voltage to the Isolator. The bootstrap amplifier, therefore, always drives the neutral node of the zener supplies to the same voltage as is the input voltage to the isolator. The net effect is that the entire zener supply rides up and down on the two high impedance current generators. The voltages supplied to the first three stages of the Isolator are always 10 volts above and 7.5 volts below the input signal voltage, regardless of what the input signal voltage may be. As a result of this scheme, the input impedance of the Isolator amplifier (as well as the common mode rejection already inherent in such a design) is greatly increased.

4A.15 The input circuitry of the Isolator amplifier centers around transistor Q10 which is a dual NPN silicon transistor consisting of two separate transistors on a common substrate. This type of tran-

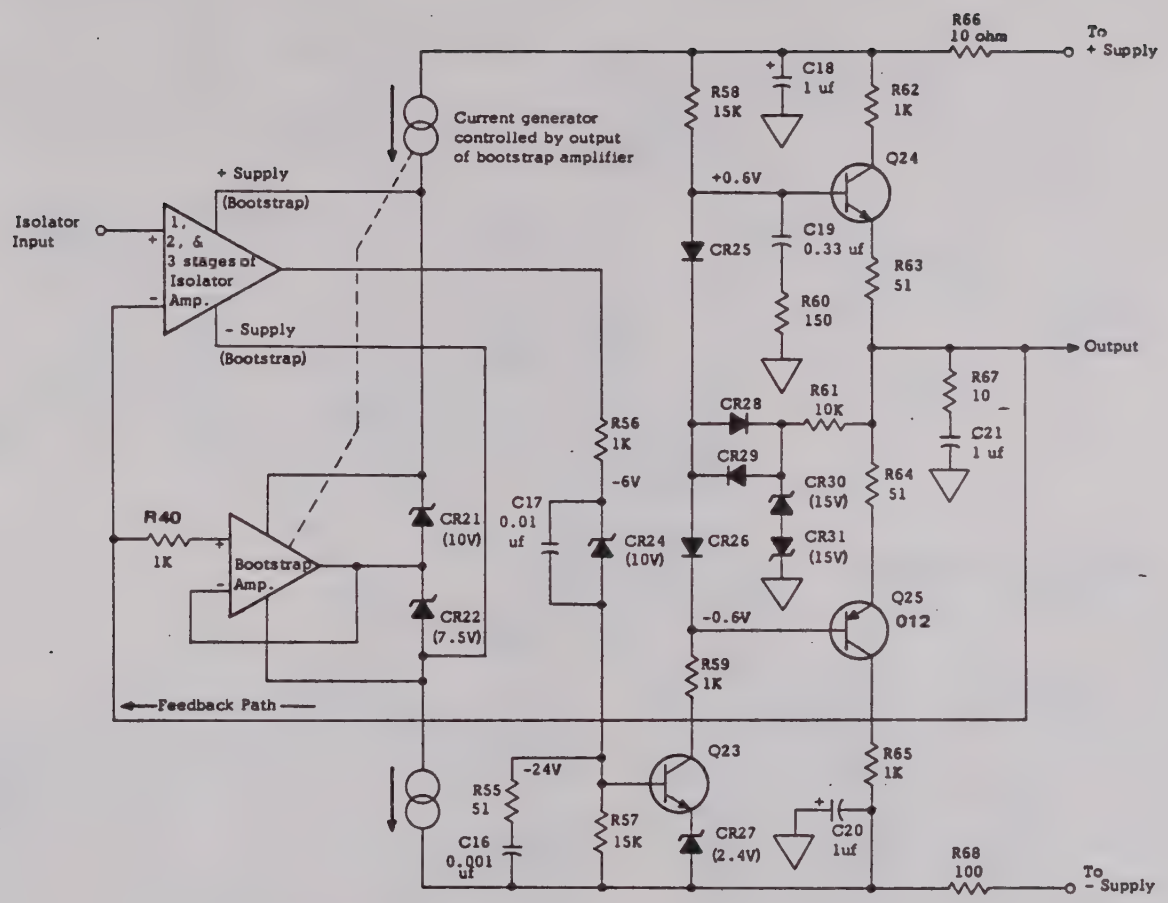


Figure 4A.5 - Isolator, showing function of bootstrap amplifier

sistor exhibits very low thermal drift characteristics. This circuit is shown in detail in figure 4A.6. Potentiometer R35, which is connected between the collector load resistors of the first stage is the front panel zero adjustment potentiometer. Resistors R31 and R37 are factory selected to electrically center potentiometer R35. The error signal (voltage potential appearing between the bases of Q10) is clamped by back-to-back diodes CR17 and CR18 so that it can not exceed 0.6 volts. The input voltage is clamped by back-to-back zener diodes CR14 and CR15 so that it will not exceed approximately ± 13 volts. Diodes CR13 and CR16 compensate for slight leakage in the back-to-back zeners. When the input voltage is excessive, input current is limited by the 100K ohm resistor R16 (see figure 4A.2-1). Zener diodes CR11 and CR12 and resistor R27 prevent excessive voltage at the active filter node which would otherwise damage the filter capacitors. The input circuit of the Isolator can withstand an input overvoltage condition of up to 100 volts for any length of time, without damage.

4A.16 In any circuit utilizing feedback to obtain high input impedance, some provision must be made to provide adequate base bias to the first stage. This biasing circuit must not introduce a low impedance in itself or the effect gained by the use of feedback will be lost. In the Isolator amplifier, the network consisting of resistors R24, R25, R26, and R30 and transistor Q9 provides a temperature compensated, adjustable current source to bias the input base of the first stage. Potentiometer R26 is factory adjusted to schedule the optimum input current into the input base so that no current is taken from the circuit to which the DMM is connected. The biasing network is connected to the bootstrapped supply which is always referenced to the input signal thus achieving a high input impedance.

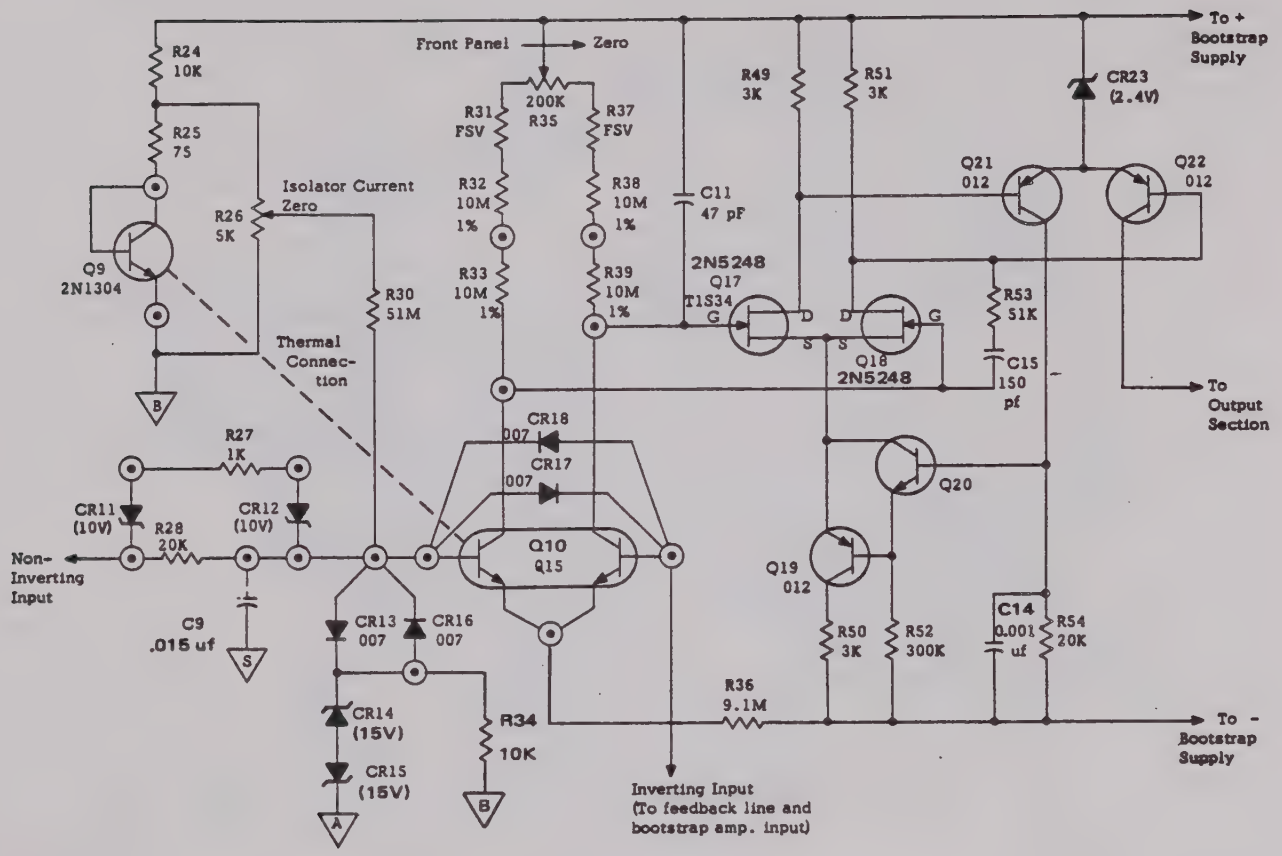


Figure 4A.6 - Isolator Amplifier Input Circuitry

4A.17 AC CONVERTER

4A.18 With AC selected, the input is routed through the AC converter (figure 4A.7) before entering the Isolator. A simplified schematic of the AC converter is shown in figure 4A.8. All AC ranging is accomplished by the voltage divider network at the input of the AC converter. This is shown in simplified form in figure 4A.8 and in detail in figure 4A.7. In the 1V range, relays K101, K102, and K103 are all open. The input signal is divided by the two 1 meg resistors R101 and R109. In the 10V range, relay K103 closes dividing the input signal by 20. In the 100V range relay K102 closes dividing the input signal by 200. In the 1000V range, relay K101 closes dividing the input signal by 2000. Thus the maximum voltage at the output of the input divider is always 0.6V for any range. In cases where the DMM is manually locked in a low range and the full scale input voltage is exceeded, zener diodes CR103 and CR104 clamp the voltage at the output of the divider at ± 3V to prevent damage to the input transistor Q101 and allow fast overload recovery. Diodes CR101 and CR102 compensate for slight leakages that exist in these zeners. Input capacitor C101 blocks any DC from entering the input divider.

4A.19 The AC Converter is composed of two separate amplifiers. This is shown clearly in figure 4A.8. The input amplifier (A-1 on figure 4A.8) consists of transistors Q101, Q102, and Q103 and is a unity gain buffer amplifier having high input impedance and low output impedance. High input impedance is achieved through the use of a single N-channel field effect transistor (Q101) at the input.

4A.20 The output amplifier consists of transistors Q108, Q109, Q110, Q111, Q112, Q113, and Q114. Resistors R128 and R139 establish the DC gain

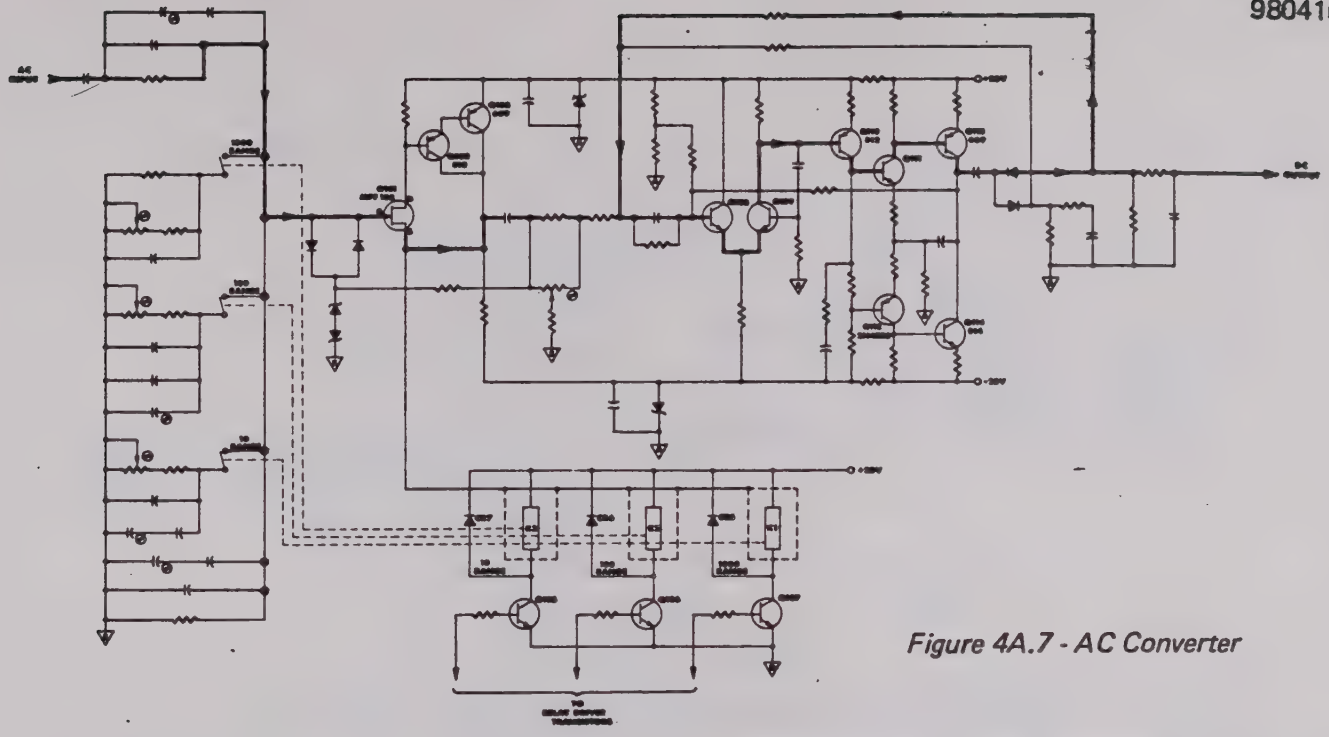


Figure 4A.7 - AC Converter

of this amplifier at 10, thus providing DC stability. At all frequencies of interest, however, capacitor C118 presents an extremely low impedance in shunt with resistor R128. This means that the AC gain of the amplifier is essentially equal to its open loop gain and for analysis purposes can be redrawn as an amplifier symbol alone, without resistors R128 and R139 or capacitor C118. This is shown in figure 4A.9. Here, capacitor C122, which serves only to provide DC isolation may also be eliminated. This amplifier is actually connected as an operational amplifier with resistor R138 or resistor R137 acting as the feedback resistor on alternate half cycles. The gain of this section is equal to the value of R121 divided into R138 (or R137) as is illustrated in figure 4A.10. Only the negative half-

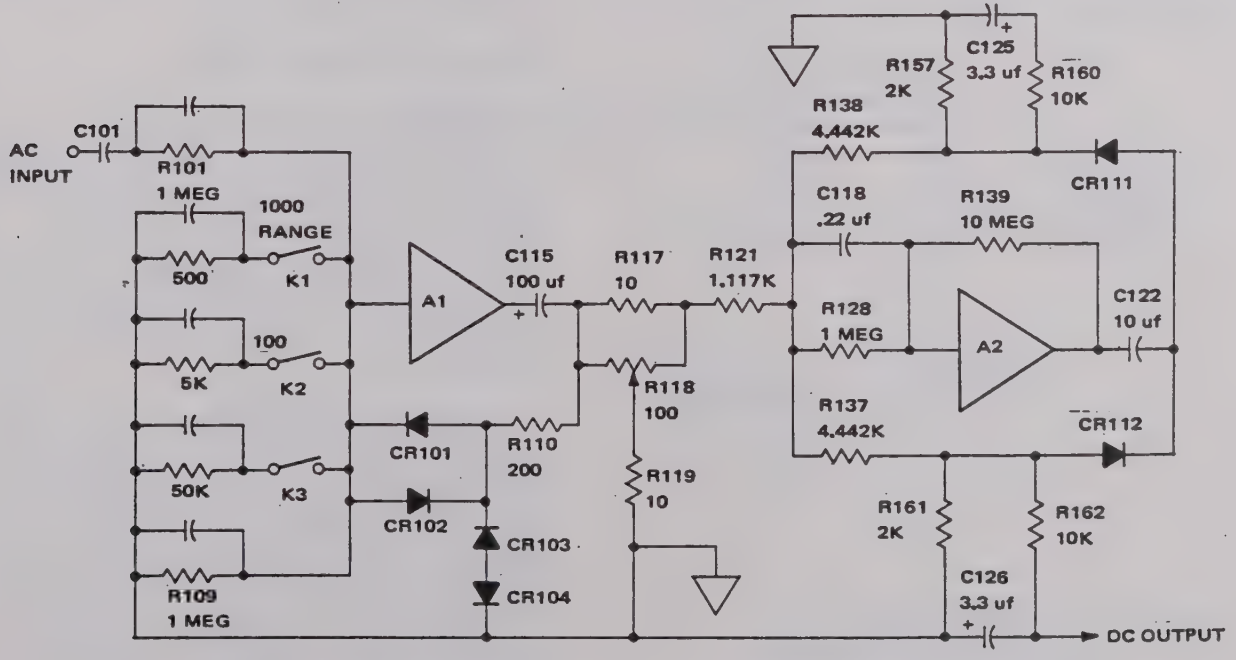


Figure 4A.8 - AC Converter - Simplified Schematic

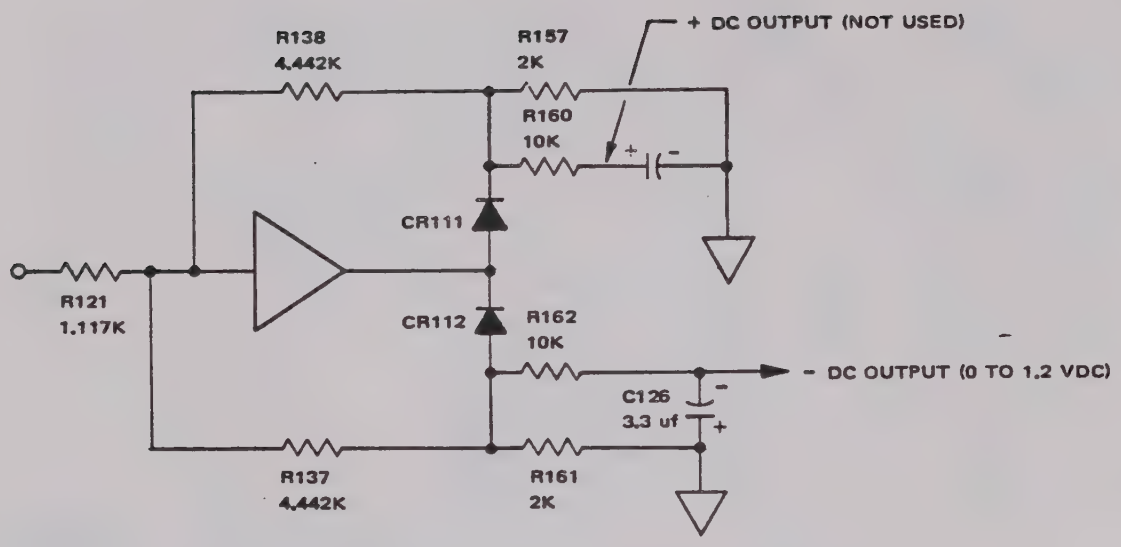
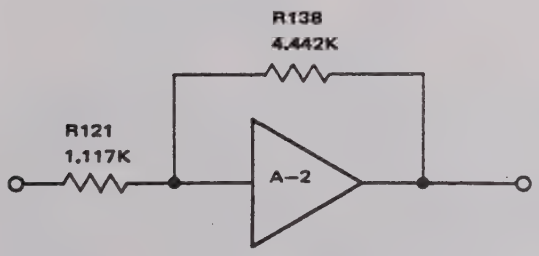


Figure 4A.9 - AC Converter Output Section - Simplified Schematic

cycle, of the rectified output is used. This is taken from the anode of diode CR112. Resistor R161 provides a proper load for diode CR112 and also provides a discharge path for capacitor C126. The rectified output is filtered by capacitor C126 across resistor R162 and is fed directly into the Isolator which is operating at a gain of 10.



$$K = \frac{R138}{R121} = \frac{4.442}{1.117}$$

$$K = 3.977$$

$$K \approx 4$$

Figure 4A.10
AC Converter Output Section,
Gain determining network

4A.21 Resistors R117 and R119 and potentiometer R118 form a simple adjustable voltage divider between amplifiers A-1 and A-2 (figure 4A.8) to set the gain of the entire system. The 1V range is calibrated by adjusting R118 and must be calibrated first, before the other ranges. Capacitor C115 provides DC isolation between the output of A-1 and the voltage divider.

4A.22 OHMS CONVERTER

4A.23 When the Ohms function is selected, the Isolator is placed in a gain of 10 configuration just as is the case in the 1 volt DC range. In addition, the Ohms Converter circuitry is switched into the DMM's input circuitry. The Ohms Converter is shown in detail in figure 4A.11 and in simplified form together with the Isolator, in figure 4A.12.

4A.24 The ohms buffer amplifier, shown in figure 4A.12, is a unity gain buffer amplifier capable of delivering one milliampere from its output. Its input is connected to the -1.0000 volt reference source located on the digitizing and display module. The output of this amplifier appears as a current source (of up to 1 ma) having a precise output terminal voltage of +1.0000 volts at all times. All output current from the ohms buffer

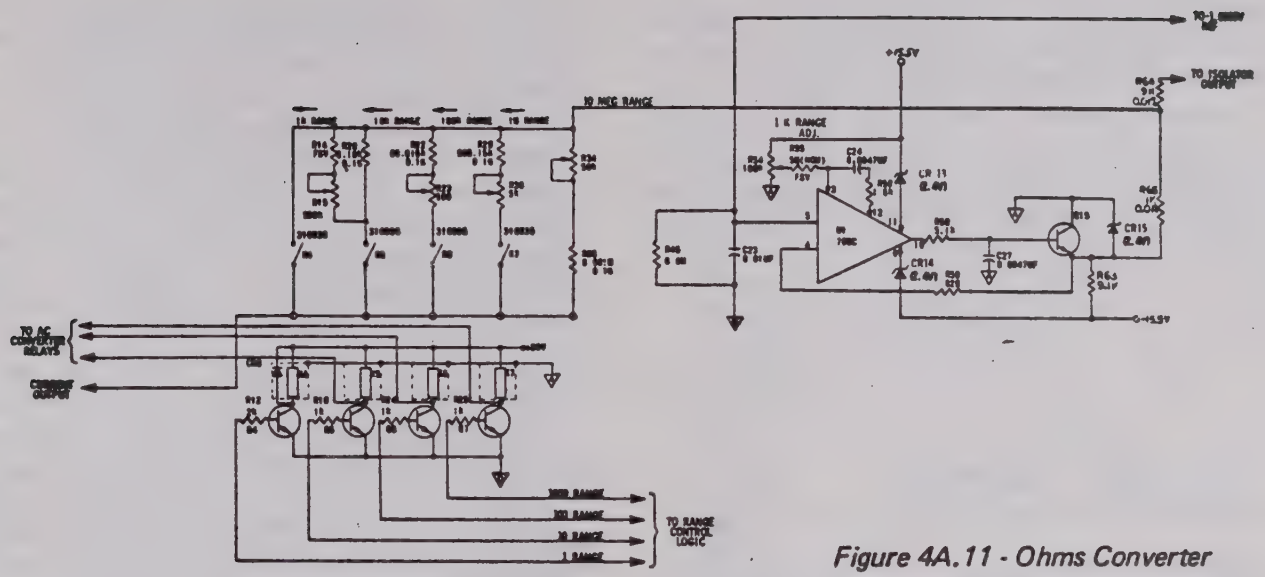


Figure 4A.11 - Ohms Converter

amplifier flows through R165, a 1 Kohm 0.01% precision resistor which is connected in series with the ohms buffer amplifier. This resistor serves to limit the output current from the ohms buffer amplifier to 1 ma.

4A.25 An analysis of circuit action in the ohms measurement configuration is best begun by considering the case where the DMM is in the 1000 ohm range. Here relay K104 (figure 4A.12) is closed so none of the current limiting resistors need be considered. To begin the analysis we shall disconnect the 1 volt ohms current source and consider the feedback configuration around the Isolator amplifier. This is shown in simplified form in figure 4A.13. Here resistors Rb and Rc represent the negative feedback network which gives the Isolator a stable forward DC gain of 10. (Here Rb and Rc are shown as 1K and 9K, in reality they are

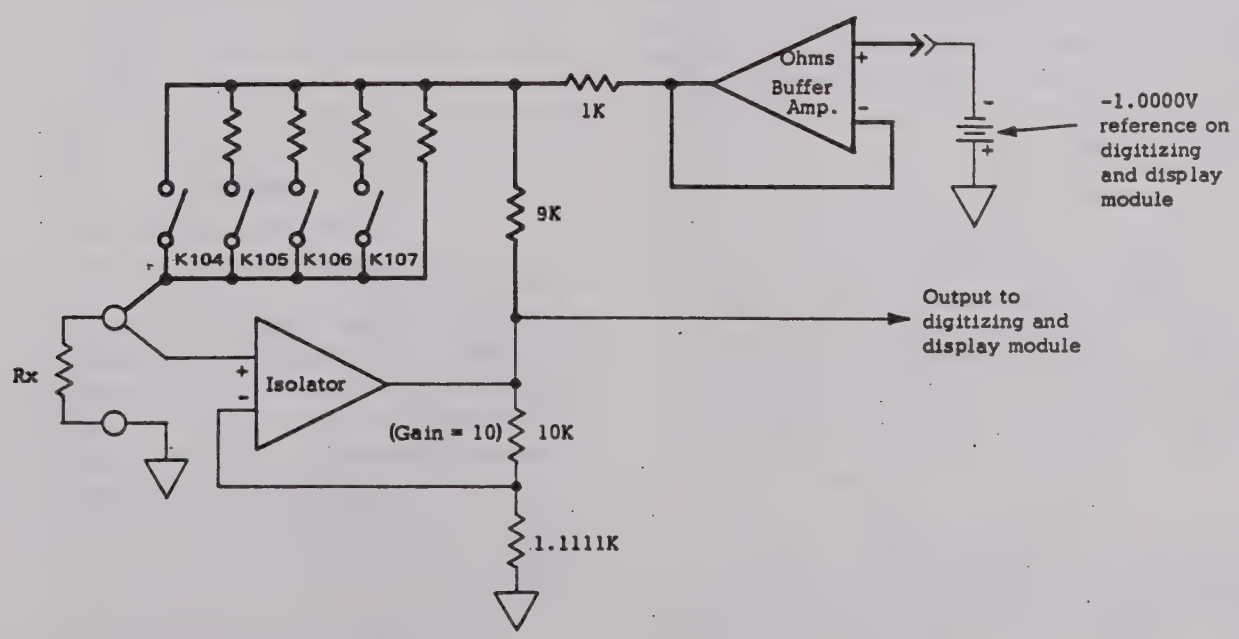


Figure 4A.12 - Ohms Converter, Simplified

1.1111K and 10K. The ratio, which is the important thing, is equal in both cases. 1K and 9K make analysis easier and still give the same gain to the Isolator) Resistors Ra and Rx, however, form a positive feedback loop which will offset the stablizing effect of Rb and Rc if Rx is very large. Resistor Rx represents the resistor being measured when the DMM is in the Ohms configuration.

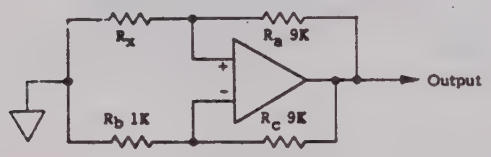


Figure 4A.13
Isolator feedback configuration in ohms mode

4A.26 Consider the case when Rx equals zero ohms. Here Ra acts only as an additional 9K ohm load on the Isolator and has no feedback effect. Since the input node to the Isolator is grounded, its output will be at zero volts. Now we shall increase the value of Rx to 1K ohm. Here the negative feedback stabilizing effect of Rb and Rc is exactly offset by the positive feedback effect of Rx and Ra. The output voltage of the Isolator may go anywhere and will probably do so in whatever direction circuit imbalances may "nudge" it. Whenever Rx is larger than 1K ohm, the positive feedback effect becomes proportionally stronger and the output voltage of the Isolator will lock against either the positive or negative power supply depending on which circuit imbalances provide the biggest "nudge".

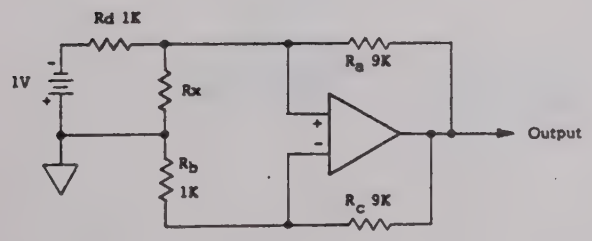


Figure 4A.14
Isolator Feedback with 1V reference supply added

4A.27 Let us now consider the effect of connecting the 1 volt ohms current source into the circuit. This is shown in figure 4A.14. Here, when Rx is infinitely large as is the case for an open circuit, the positive feedback effect of Ra predominates. The -1 volt source connected to the Isolator's input terminal provides a very powerful "nudge" and the output of the Isolator locks against its negative supply voltage. Here again, if Rx equals zero ohms, the input to the Isolator amplifier is grounded and its output is zero volts. For values of Rx between zero and 1200 ohms, the feedback circuit consisting of Ra, Rb, Rc and Rx will allow the output voltage of the Isolator amplifier to reach an equilibrium state somewhere between zero and -12 volts with the current through Rx always equal to 1 milliampere. This concept may be better illustrated by representing the entire ohms measurement circuit as a current-stable bridge. This is shown in figure 4A.15.

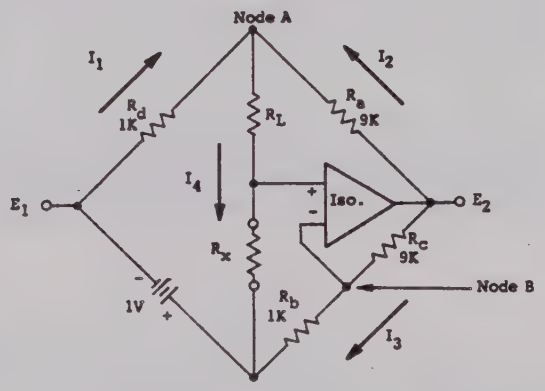


Figure 4A.15
ohms measurement circuit
shown as a current-stable bridge

4A.28 Refer to figure 4A.15. Here the ohms measuring circuit is shown as a current-stable bridge. Resistor R_L serves to limit the current through Rx on the higher ohms ranges. On the 1000 ohms range (presently under consideration) R_L equals zero ohms. Circuit action can be shown by picking values for Rx (between 0 and 1200 ohms) and analyzing circuit operation:

(a) Assume Rx equals 100 ohms. Current

flows out of the 1 volt source through Rd and Rx into circuit common. The 1100 ohm series combination of Rd and Rx limits the current through Rx to 909 microamperes. The 909 microamperes flowing through Rx causes a voltage drop of -90.9 millivolts across it. The -90.9 millivolts across Rx produces an output of -.909 volts at the output of the Isolator amplifier due to the gain of 10 produced by resistors Rb and Rc. Here the output voltage and current through Rx would remain were it not for the positive feedback effect afforded by resistors Ra and Rx. This causes the output voltage from the Isolator to continue to rise until the voltage at Node A (figure 4A.15) exactly equals the voltage at node B. (The output of an amplifier is stable only when its input error signal equals zero.) The rising output voltage from the Isolator pumps current into node A through Ra causing the voltage at node A to rise. This current is I_2 on figure 4A.15. As the voltage at node A rises, current I_1 decreases slightly. The equillibrium point is reached when the voltage at node A exactly equals the voltage at node B. This occurs when I_1 equals 900 microamperes, I_2 equals 100 microamperes, I_3 equals 100 microamperes and I_4 equals 1000 microamperes (1 milliampere). Voltage E_2, the Isolator output voltage, is equal to I_3 times Rb + Rc. This is equal to -1.0000 volts which is displayed as 0.1000 kilohms on the DMM. 0.1 kilohms equals 100 ohms, the value of Rx.

(b) If Rx is assumed to equal 500 ohms, a very similar effect takes place. Here the 1500 ohms in series with the 1 volt limits the initial current from the 1 volt source to 666 microamperes through Rx. This produces an initial terminal voltage across Rx of 333 millivolts which is bootstrapped up by the positive feedback action of Ra and Rx to 500 millivolts. Here I_1 equals 500 microamperes, I_2 equals 500 microamperes, I_3 equals 500 microamperes and I_4 again equals 1 milliampere. The voltage at the output of the Isolator now equals I_3 x (Rb + Rc) which is -5.000 volts. The DMM displays 0.5000 kilohms. 0.5000 kilohms equals 500 ohms, the value of Rx.

4A.29 On the higher ohms ranges, current limiting resistor R_L (figure 4A.15) is inserted in series with Rx to limit the equillibrium current through it to a value that will result in a full scale IR drop across Rx of one volt on each range. The full scale current through Rx is given in table 4A.2 below for each range.

RANGE	CURRENT THROUGH UNKNOWN
1 Kilohm	1000 Microamps
10 Kilohm	100 Microamps
100 Kilohm	10 Microamps
1000 Kilohm	1 Microamp
10,000 Kilohm	100 Nanoamps

Table 4A.2 - Current thru Unknown resistor for each ohmmeter range

4A.30 RANGE CONTROL (Figure 4A.16)

4A.31 Ranging of the instrument is controlled by a three-stage flip-flop counter driven by control signals from the Digitizing and Display Module. The control signals are Up Range, Down Range, and $\overline{\text{Strobe}}$.

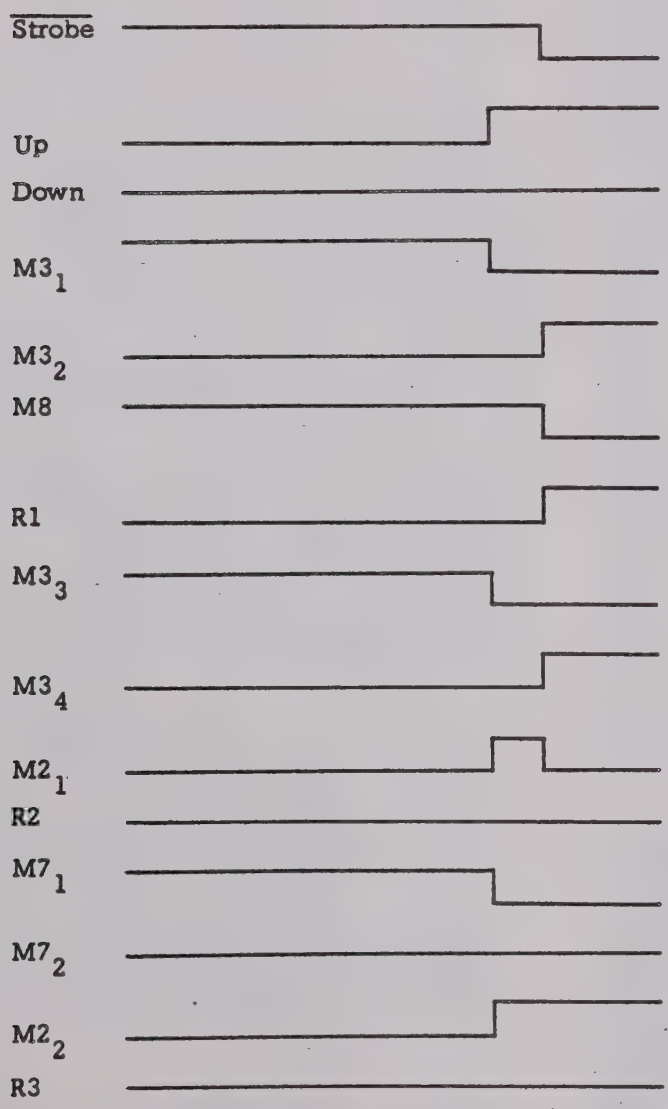
4A.32 Up Range is true when the instrument is not on the highest range (1000 in volts or 10,000 in ohms) and the counter in the Digitizing and Display Module registers 12000 or higher. Down Range is true when the instrument is not in the lowest range and the counter in the Digitizing and Display Module registers 00999 or less. Strobe is true during the measurement period. The negative-going edge of this signal indicates the end of the measurement.

4A.33 The range counter counts up or down in response to the Up Range and Down Range control signals. The state of the flip-flops corresponds to the codes and ranges listed in table 4A.1 A manu-

ally selected range "forces" the flip-flops to the proper state by clamping the appropriate counter outputs to common.

4A.34 A one-shot circuit provides a timeout (delay) of about 0.5 seconds at the end of a measurement period to allow time for ranging and for settling time of analog circuits. During this period, the HOLD line goes positive. This line is tied to the input of the control logic circuits in the Digitizing and Display Module where the positive level prevents a new reading from being taken.

4A.35 When operating in a selected range, rather than autorange, the HOLD line is permanently strapped to common by the range switch and new readings are allowed during a range changing attempt.



Example shows range counter initially in $\overline{R1}\ \overline{R2}\ \overline{R3}$ state representing range of 1. "Up" changes counter state to R1 $\overline{R2}\ \overline{R3}$ representing range of 10.

Figure 4A.16 - Range Control

SECTION 4B

THEORY OF OPERATION OF THE DIGITIZING AND DISPLAY MODULE

4B.1 INTRODUCTION

4B.2 The Digitizing and Display Module, shown in simplified form in figure 4B.1 and in detail in the schematic diagram section at the back of this manual is, in itself, a complete DC digital voltmeter. The module will display the voltage and polarity of any DC input signal between zero and 10V full scale (11.9999 with overrange). A 10V input signal gives a displayed reading of 10,000. The Digitizing and Display Module is divided into two main categories, the analog circuitry and the digital circuitry. In addition are the solid state switches at the input to the Integrator which are switched by the digital circuitry but perform an analog function. The digital circuitry is entirely constructed with integrated circuits with the exception of the transistors which drive the decimal points and polarity and overload indicators. Decimal points are placed by the ranging logic which is located on the Signal Conditioning Module. The driver transistors which actually switch the decimal points are located on the Digitizing and Display Module, their driving signal, however, comes from the ranging logic on the Signal Conditioning Module. The analog circuitry is entirely constructed around monolithic, linear, differential amplifier, integrated-circuits, which are connected either as inverting operational, or non-inverting potentiometric amplifiers. The solid-state switching circuitry, at the input to the integrator, consists of four N-channel field effect junction transistors. They and their associated driving circuitry comprise the only other section of the Digitizing and Display Module constructed from discrete components. The Digitizing and Display Module may be broken up into the following sub-sections:

I. ANALOG
   - (a) Reference supplies
   - (b) Integrator
   - (c) Null Detector

II. DIGITAL
   - (a) Clock oscillator
   - (b) Counter-readout
   - (c) Ranging logic
   - (d) Polarity sensing logic

III. FET SWITCHING CIRCUITRY

4B.3 REFERENCE SUPPLIES

4B.4 BASIC OPERATION OF THE REFERENCE SUPPLIES

4B.5 These supplies, shown in detail in figure 4B.2 and in a simplified form in figure 4B.3. They are built around two types of 301A integrated-circuits, differential amplifiers, each of which is housed in a low profile TO-5 package. The primary reference supply is the +10 volt supply. The negative supply inverts the +10V supply to -10V using an operational amplifier.

4B.6 The stability of the +10V reference supply is dependent upon the inherent stability of the reference zener. These zeners are individually graded by Dana to obtain the maximum long term stability and minimum temperature coefficient (TC). The zener and the series resistor through which it is biased are connected across a precision 10V source. The series resistor is then factory selected (FSV) to obtain the biasing current which will provide optimum temperature stability (TC). The selected resistor and zener are then installed

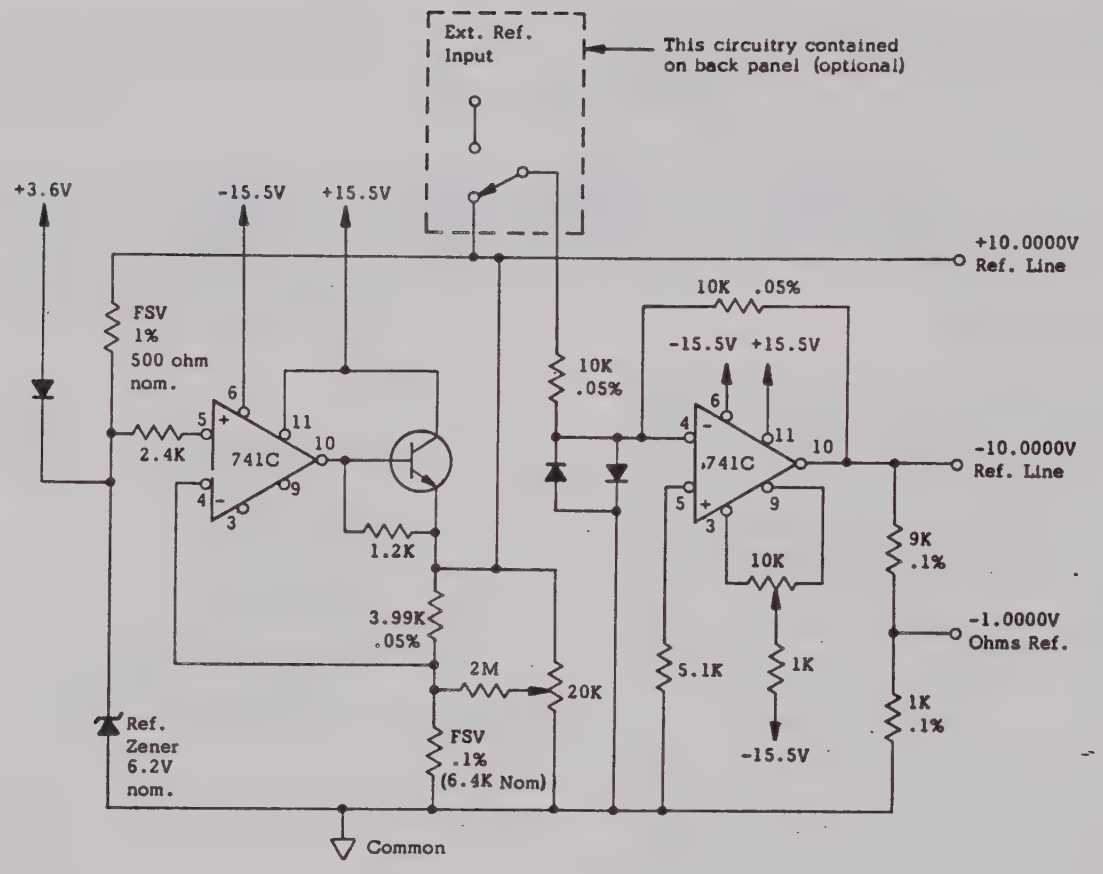


Figure 4B.2 - Reference Supplies

in each DMM as a pair, matched to each other.

4B.7 The amplifier around which the +10V reference supply is constructed consists of an integrated-circuit differential amplifier connected as a non-inverting, potentiometric feedback amplifier. The feedback network sets the forward closed-loop gain of the amplifier at approximately 1.6. A potentiometer in the feedback circuit provides a "fine" adjustment of the gain for calibration purposes. The reference zener and its biasing resistor are connected between the output of the +10V reference supply and circuit common. The cathode voltage of the reference zener provides the input signal to the amplifier in the +10V reference supply. This circuit is shown in figure 4B.2.

4B.8 The -10V reference supply consists of an integrated-circuit differential amplifier which is operated as an operational amplifier with a closed loop gain of one. Since an operational amplifier is an inverting amplifier it simply inverts the +10V reference to -10V. The input impedance of an operational amplifier is equal to the value of the input summing resistor, which in this case is 10K. Thus, the -10V supply draws only one milliampere from the +10V supply.

4B.9 ANALYSIS OF REFERENCE SUPPLY CIRCUIT OPERATION

4B.10 The feedback network of the +10V reference supply, together with the reference zener and its biasing resistor may be looked upon as forming a simple bridge. This is shown in figure 4B.3 which is a simplified schematic of the positive and negative reference supplies. The feedback network sets the forward closed loop gain of the amplifier at approximately 1.6.

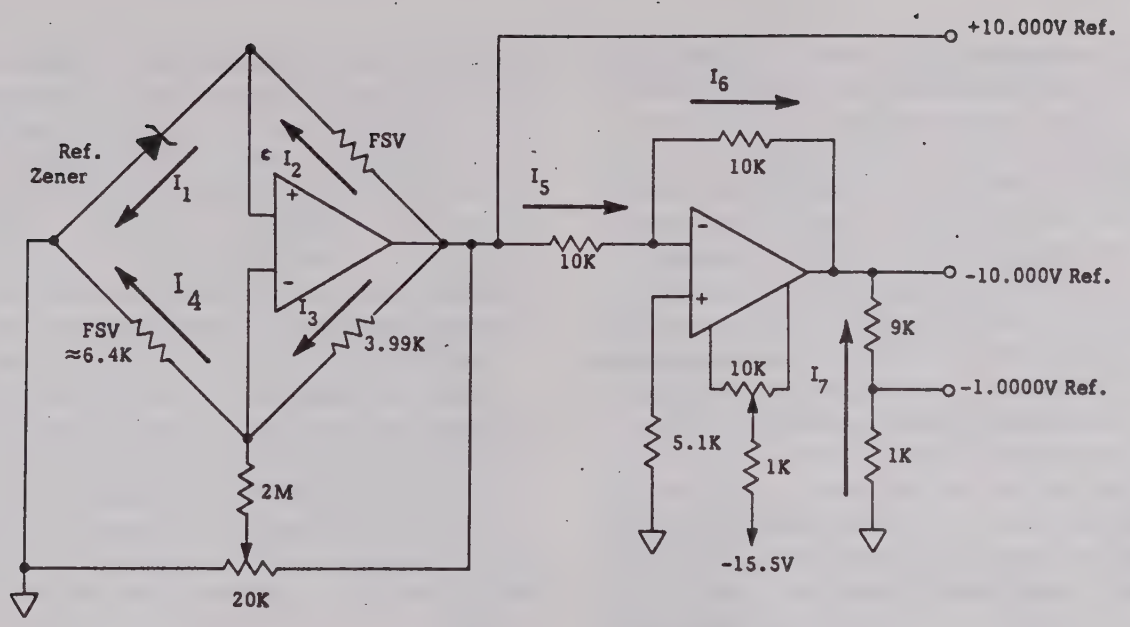


Figure 4B.3 - Simplified Schematic - Reference Supplies

4B.11 In operation, when power is first applied the voltage from the +3.6V power supply forward biases the diode connected between the +3.6V supply and the cathode of the reference zener causing the voltage at the cathode of the zener to rise to approximately +3 volts. As this voltage is below the breakover point of the zener, no current flows through it. Since the input to the reference amplifier is connected to the cathode of the zener, the output voltage from the reference amplifier also rises. As the output voltage from the reference amplifier rises it is fed back in a positive feedback loop to the input of the reference amplifier by the zener biasing resistor which is connected between the output of the reference amplifier and the cathode of the zener (i.e. the input to the reference amplifier). This positive feedback action causes the output voltage from the reference amplifier to continue to rise until the breakover point of the zener is reached. This occurs at a zener cathode voltage of approximately 6.2 volts. The DC open loop gain of the reference amplifier is approximately 100,000. This means that the error signal required to sustain an output level of 10V is approximately 100 microvolts. Thus the bridge circuit will balance when the voltage at the inverting amplifier input (which is connected to the feedback network) is approximately 100 microvolts lower than the voltage at its non-inverting input (which is the zener breakover voltage). When the circuit is balanced, the reference amplifier is delivering currents I_2 and I_3 into the bridge. Current I_2 equals I_1 and is the optimized zener bias current previously discussed. Current I_3 equals I_4 and is approximately equal to 10 volts across 10K or 1 ma. The 20K potentiometer connected between the +10V reference output and circuit common provides a "fine" adjustment of the gain of the reference amplifier over a limited range. This allows the reference supply to be calibrated to precisely +10.000 volts.

4B.12 The negative 10V reference supply is designed around the same type of integrated circuit differential amplifier as is the +10V supply. The difference is that, whereas the +10V supply uses the amplifier connected in a non-inverting potentiometric configuration, in the -10V supply the amplifier is connected as an inverting operational amplifier. This amplifier is operated with a closed loop gain of -1. As is the case with the positive reference amplifier, the negative reference amplifier has an open loop gain of approximately 100,000. Thus the maximum error signal across its input terminals needed to sustain an output of 10V is 100 microvolts. This keeps the voltage at the amplifier's inverting input terminal (summing node) from exceeding 100 microvolts which means

that, for all practical purposes, it can be considered as equal to ground potential. When the operational amplifier circuit is connected to the +10V reference supply (or, when the instrument is first turned on) the positive 10V applied to the inverting input of the differential amplifier causes its output to move in a negative direction. This causes current I_5 to flow into the summing node of the operational amplifier through the 10K input resistor. As the action of the operational amplifier attempts to hold the summing node voltage at a point very near ground potential, the input current is determined by the value of the input resistor. In this case the current is 10 volts across 10K or 1 ma. The circuit balances at the point where exactly the same current that enters the summing node through the input resistor (I_5) leaves the summing node through the feedback resistor (I_6). This is the basic principle of operation behind the operational amplifier. (The input impedance of the differential amplifier itself is very high and thus consumes virtually no current.) The gain of the operational amplifier is determined by the relationship of the input resistor to the feedback resistor. If they are equal, as is the case here, exactly the same current will flow through each when each has exactly the same voltage dropped across it. This can occur, in this case, only when the output voltage from the negative reference amplifier is -10 volts. The gain accuracy of the operational amplifier is determined by the precision of the two resistors which form the gain determining network. The 20K potentiometer connected between pins 1 and 5 of the operational amplifier is a provision for zeroing the amplifier during calibration of the ratio function.

4B.13 The instrument may be equipped for use as a ratiometer (optional). When so operated, the reference voltage, which may be between zero and +10V DC, is applied to the operational amplifier through a switch located on the back of the instrument. The operational amplifier inverts the reference signal just as it does the +10V reference supply.

4B.14 INTEGRATOR

4B.15 The integrator, shown in detail in figure 4B.4 and in simplified form in figure 4B.1, is the center of the analog to digital conversion circuitry. It is designed around a high-gain, monolithic, integrated-circuit differential amplifier. The circuit is connected as an operational amplifier, having a

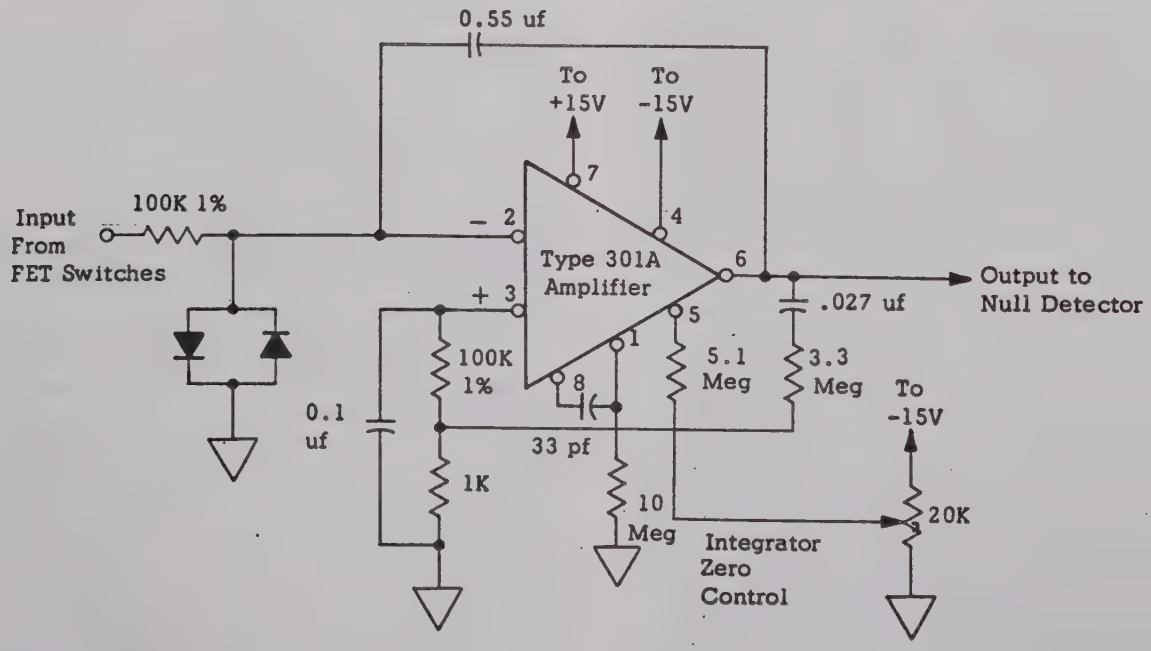


Figure 4B.4 - Schematic, Integrator

summing resistor of 200K ohms, and in the feedback element is a 0.55 microfarad capacitor. In operation, the circuit functions as outlined below.

4B.16 BASIC OPERATION OF THE INTEGRATOR

4B.17 Immediately prior to the beginning of a new reading the integrator is in a "reset" state. Its input and output are both at zero volts. When the instrument begins a new reading a solid-state switch Q21 closes, connecting the input of the Integrator to the output from the Signal Conditioning Module. At this point the output voltage from the integrator begins to move in a polarity opposite to the polarity of the voltage at its input. The Integrator's output voltage moves at a rate which is equal to the charging rate of the 0.55 microfarad feedback capacitor charged at a constant current which is equal to the $\frac{E}{R}$ relationship of the input voltage to the 200K ohm summing resistor. The amplifier acts as a constant current source which charges the capacitor. This charging of the feedback capacitor by a constant current source produces a linear ramp at the output of the Integrator, the change in whose voltage is given by the formula:

(1) $$\Delta V = \frac{-Ein\ Ts}{RC}$$

Where: ΔV = The change in voltage from the integrator

Ein = The input signal voltage

Ts = The fixed time that the switch connecting the Integrator's input to the input signal remains closed.

R = The Integrator's summing resistor

C = The value of the Integrators feedback capacitor.

The solid-state switch connecting the input of the Integrator to the signal voltage remains closed for a fixed period of time. This is referred to as the signal integration time (Ts). At the time that Ts begins, an oscillator of frequency f begins advancing the digital counter. The counter counts until a fixed number of counts (Cf) is reached.

4B.18 When fixed count (Cf) is reached, the signal integration time (Ts) is terminated and the counter goes to zero. At this point the solid-state switch which connected the signal voltage to the Integrator's input opens and another switch closes connecting the Integrator's input to a precision 10V reference supply. This begins the reference integration period (Tr). The reference supply is opposite in polarity to the polarity of the input signal voltage. This causes the output voltage from the Integrator to ramp back toward zero until zero is reached, at which time the null detector senses the null state and causes the reference integrator time to be terminated. The counter accumulates oscillator counts from the beginning of Tr until Tr is terminated. At this time the counter contains a number of counts (Cx), which is the number displayed in the DVM readout. Since Tr ends with the output voltage from the Integrator at the same level as when Ts started, the changes in voltage at the output of the Integrator must be equal and opposite, thus:

(2) $$\Delta V = \frac{-Eref\ Tr}{RC}$$

Where: ΔV = The change in output voltage from the Integrator

Eref = The voltage of the reference supply

Tr = The reference integration time

R = The value of the Integrator's summing resistor

C = The value of the Integrator's feedback capacitor

Operating on equations (1) and (2), we may equate quantities equal to ΔV:

(3) $$\frac{-Ein\ Ts}{RC} = \frac{-Eref\ Tr}{RC}$$

And by multiplying both sides of equation (3) by RC we have:

(4) $-Ein\ Ts = -Eref\ Tr$

Dividing both sides of eq. (4) by - Eref:

(5) $$\frac{-Ein\ Ts}{-Eref} = Tr$$

Eq. (5) is equal to:

(6) $$Tr = \frac{Ein\ Ts}{Eref}$$

Ts is determined by a fixed number of counts (Cf), therefore:

(7) $$Ts = \frac{Cf}{f}$$

Where f is the oscillator frequency

Similarly:

(8) $$Tr = \frac{Cx}{f}$$

By substituting the equivalent values of Ts and Tr in equation (6) we obtain:

(9) $$\frac{Cx}{f} = \frac{Ein\ Cf}{Eref\ f}$$

And by multiplying both sides of eq. (9) by f:

(10) $$Cx = \frac{Ein\ Cf}{Eref}$$

Equation (10) is very important because it shows that the number displayed by the DVM (Cx) is affected only by Cf, which is an invariant digital number, Eref, which is a precision reference voltage, and Ein, which is the voltage to be measured.

The measurement accuracy is entirely based upon the ratio of the signal integration time, a fixed number of counts (Cf), to the reference integration time, a variable number of counts (Cx). It is completely unaffected by oscillator frequency (f), or the RC components in the Integrator, provided only that these quantities remain stable during the time period required to take a measurement.

48.19 ILLUSTRATION OF INTEGRATOR OPERATION BY EXAMPLE

48.20 Each time the instrument begins a new reading a solid-state switch closes, connecting the input of the Integrator to the signal output from the Signal Conditioning Module. Since the integrator is connected as an operational amplifier, feedback action keeps the voltage at the summing node (i.e. the inverting amplifier input) at very nearly zero volts. (For this reason, many engineers refer to the summing node as a "virtual ground".) As the summing node is at ground potential, the input current flowing through the summing resistor is equal to the value of the input voltage divided by 200K ohms. The inverting action of the amplifier causes the voltage at its output to move in a polarity opposite the polarity at the input to the summing resistor. The rate is equal to the charging rate of the 0.55 microfarad capacitor charged at a constant current which is equal to the $\frac{E}{R}$ relationship of the input voltage to the 200K ohm summing resistor. The amplifier acts as a constant current source which charges the capacitor. This action produces a linear ramp at the output of the integrator amplifier whose slope is given by the formula:

$$S_1 = -\left(\frac{Ein}{RC}\right)$$

Where: S_1 = The charging slope in volts per second

Ein = The input voltage to the integrator

R = The value of the integrator summing resistor

C = The value of the integrator feedback capacitor.

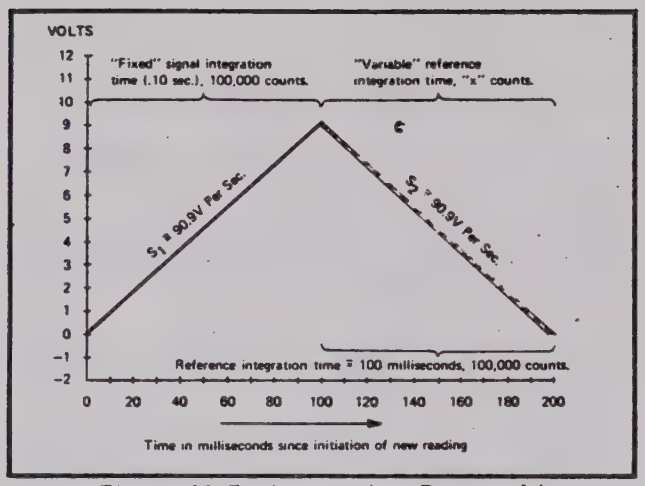

VOLTS
"Fixed" signal integration time (.10 sec.), 100,000 counts.
"Variable" reference integration time, "x" counts.
S_1 = 90.9V Per Sec.
S_2 = 90.9V Per Sec.
Reference integration time = 100 milliseconds, 100,000 counts.
Time in milliseconds since initiation of new reading

Figure 4B.5 - Integration Ramp with a −10V Input Signal

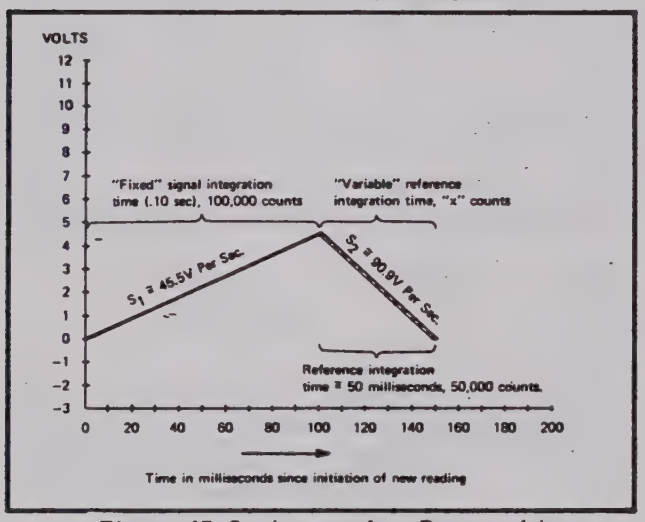

VOLTS
"Fixed" signal integration time (.10 sec), 100,000 counts
"Variable" reference integration time, "x" counts
S_1 = 45.5V Per Sec.
S_2 = 90.9V Per Sec.
Reference integration time = 50 milliseconds, 50,000 counts.
Time in milliseconds since initiation of new reading

Figure 4B.6 - Integration Ramp with a −5V Input Signal

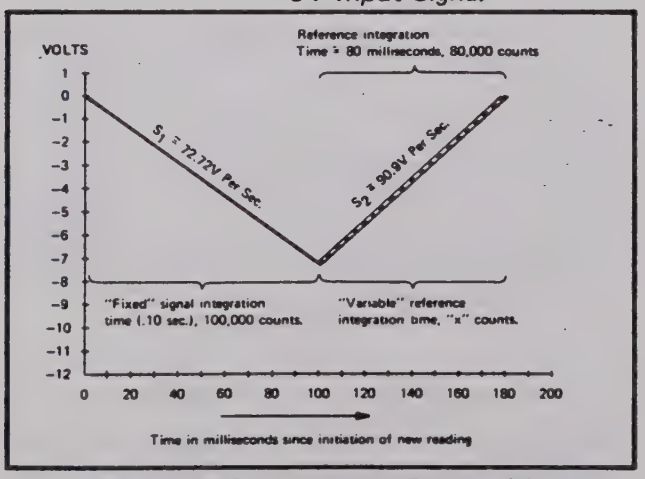

VOLTS
Reference integration Time = 80 milliseconds, 80,000 counts
S_1 = 72.72V Per Sec.
S_2 = 90.9V Per Sec.
"Fixed" signal integration time (.10 sec.), 100,000 counts.
"Variable" reference integration time, "x" counts.
Time in milliseconds since initiation of new reading

Figure 4B.7 - Integrator Ramp with a +8V Input Signal

If we assume an input to the integrator of -10V, the slope of the ramp is:

$$S_1 = -\left(\frac{Ein}{RC}\right) = -\left(\frac{-10}{(2.10^5)\ (5.5 \times 10^{-7})}\right) =$$

$$-\left(\frac{-5.0}{5.5 \times 10^{-2}}\right)$$

$$S_1 = -(-.909 \times 10^2) = -(-90.9)$$

$$S_1 = +90.9 \text{ volts per second}$$

The digital circuitry keeps the FET switch connecting the signal to the integrator closed for a period of exactly 0.10 second (100 milliseconds). If the input signal is -10V, the inverting action of the integrator causes its output voltage to ramp in a positive direction at a 90.9 volt per second rate. The voltage at the output of the integrator at the end of the allotted 100 millisecond signal integration time is given by the formula:

$$V = S_1 t$$

Where:

- V = The integrator's output voltage at the end of the integration time
- S_1 = The charging slope in volts per second during signal integration
- t = The total integration time

In this case "t" is fixed at 0.10 second and the charging slope is 90.9 volts per second. Thus:

$$V = S_1 t$$
$$V = 90.9 \times .10$$
$$V = 9.09$$

A slope of 90.9 volts per second, ramping for a period of 100 milliseconds, will allow the voltage at the output of the integrator to reach a level of exactly +10 volts. This is shown as slope S_1 in figure 4B.5. If the input signal to the integrator were -5V, rather than -10V, the slope during the signal integration time would be 45.5 volts per second (which follows from the above formulas).

This would allow the output voltage from the integrator to reach a level of +4.54V during the allotted 100 millisecond integration time. This is shown as slope S_1 in figure 4B.6. If we assume an input signal to the integrator of +8V, the slope during the signal integration time is:

$$S_1 = -\left(\frac{Ein}{RC}\right)$$

$$S_1 = -\left(\frac{8}{(2.10^5)\ (5.5 \times 10^{-7})}\right)$$

$$S_1 = -\left(\frac{800}{11}\right)$$

$$S_1 = 72.72 \text{ volts per second}$$

A slope of -72.7 volts per second, charging for a period of .10 second gives an integrator output voltage of:

$$V = S_1 t$$
$$V = (-72.7) \times .10$$
$$V = -7.27$$

This is shown as slope S_1 of figure 4B.7. From this it can be seen that, *in any case, the output voltage from the integrator at the end of the signal integration period will always be of opposite polarity, to the voltage at the integrator input.*

4B.21 At the end of the signal integration period the FET switch connecting the integrator's input to the output signal from the signal conditioning module opens. Simultaneously, one of two FET switches, the Negative Reference Switch Q22, or the Positive Reference Switch Q23, closes and connects the integrator input to either the -10.000V or the +10.000V reference supply. The Reference switch that closes is determined by the Polarity of the Integrator input signal. Thus, the reference switch that has the opposite polarity to the Integrator input will close. At this point the output voltage from the integrator begins to ramp back toward zero volts. This is known as the Reference Integration Slope Period. The Reference Integration Slope is calculated by the formula:

$$S_2 = -\frac{E\ ref}{RC}$$

Where:

S_2 = Reference Integration Slope

E ref = Reference voltage (+10.000V or -10.000V)

R = Value of the integrator summing resistor

C = Value of the integrator feedback capacitor

From the above formula it can be seen that the Reference Integration Slope will always be +90.9 volts per second when the signal being measured is positive (because the -10.000 volt reference supply is switched into the integrator's input) and -90.9 volts per second when the signal being measured is negative. The slope is 90.9 volts per second because the reference supply voltage is 10 volts. The time it takes the output voltage from the integrator to reach zero volts after the start of the reference integration period is given by the formula:

$$Tr = \frac{V}{S_2}$$

Where:

Tr = Reference integration time

V = Output voltage from integrator at the end of the signal integration time

S_2 = Slope of reference integration

Thus, for the case where the signal being measured is -10V, the output voltage from the integrator at the end of the signal integration time is +9.09V. The slope is 90.9 volts per second and since the signal being measured is of negative polarity the slope of reference integration will also be of negative polarity. The time required for the output voltage from the integrator to reach zero volts is calculated as follows:

$$Tr = \left|\frac{V}{S_2}\right|,$$

$$Tr = \left|\frac{9.09V}{-90.9}\right|$$

$$Tr = |-.10|$$

$$Tr = .10 \text{ second}$$

This is shown by slope S_2 of figure 4B.5. Similarly, the reference integration time is 50 milliseconds when the input signal is 5 volts and 80 milliseconds when the input signal is 8 volts. These are shown as slope S_2 in figures 4B.6 and 4B.7.

4B.22 The reference integration time, outlined above, is measured and converted to a digital form for display in the DVM readout.

The reading displayed is calculated by the formula;

$$D = Tr\,f$$

Where:

D = The displayed reading

Tr = The reference integration time

f = The clock frequency of the instrument (1 MHz)

Thus, in the case where the input voltage being measured is -10V, the reference integration time is .10 second (as shown above) so the displayed reading is:

$$D = Tr\,f$$

$$D = .10 \times 1{,}000{,}000$$

$$D = 100{,}000$$

And when the input signal is 8V, the displayed reading is:

$$D = Tr\,f$$

$$D = .080 \times 1{,}000{,}000$$

$$D = 80{,}000$$

Further manipulation of the D = Tr f equation reveals that the reading displayed by the instrument is a function of the ratio of the reference integration time to the signal integration time.

$$D = Tr\,f$$

$$\left(\frac{Ts}{Ts}\right) D = (Tr\,f)\left(\frac{Ts}{Ts}\right)$$

$$D = \frac{Tr\,f\,Ts}{Ts}$$

$$D = \frac{Tr}{Ts}(Ts\,f)$$

The case when the input signal is 8V may again be used to illustrate. The clock frequency (f) is 1MHz and the signal integration time Ts is .10 second. When the input signal is 8V, the reference integration time Tr is .08 second.

$$D = \frac{Tr}{Ts}(Ts\,f)$$

$$D = \frac{Tr}{Ts} \times (.10 \times 1{,}000{,}000)$$

$$D = \frac{Tr}{Ts} \times 100{,}000$$

$$D = \frac{.08}{.10} \times 100{,}000$$

$$D = .8 \times 100{,}000$$

$$D = 80{,}000$$

4B.23 NULL DETECTOR

4B.24 The Null Detector, shown in detail in figure 4B.8 and in simplified form as a part of figure 4B.1 is a high gain non-inverting amplifier. The Null Detector is designed around a high-gain, monolithic, integrated-circuit differential amplifier. The circuit is of the potentiometric feedback type and has a closed-loop gain of 1100. The 20K resistor in series with the input and the two back to back diodes serve to limit the input voltage to the null detector to $\pm$ 0.6 volts. The Null Detector has two outputs. One output goes directly to the digital circuits. The second output, a diode drop away from the first output, feeds to the FET Reset switch. The Reset switch is one of four FET switches connected to the input of the Integrator. Refer to figure 4B.8.

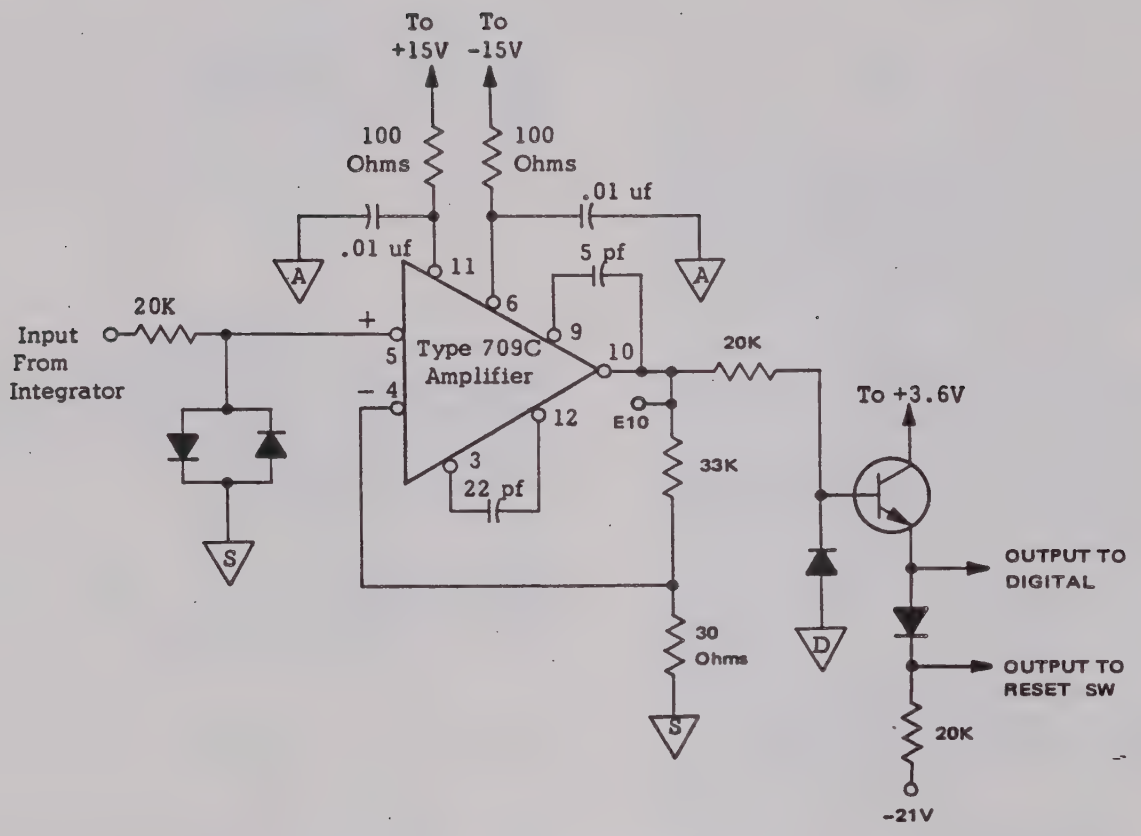


Figure 4B.8 - Null Detector

4B.25 OPERATION OF THE DIGITIZING AND DISPLAY MODULE

4B.26 Refer to figure 4B.1. Figure 4B.1 is a simplified version of the actual schematic which appears in the schematic section at the rear of this manual. As shown, all lines and logic levels are as they actually appear in the instrument. Nor gates which are used as inverters are shown as inverters in figure 4B.1. Similarly, nor gates which are interconnected to form RS flip flops are shown as RS flip flops.

4B.27 In operation, the counter, which consists of five individual integrated-circuit decades, is continuously running and is never reset. The clock is gated to stop the counter whenever the instrument is in "hold" or during "strobe" time. A five decade counter can count only to 99999 whereupon it resets itself to 00000. A new reading is initiated every third time the counter reaches 00000.

4B.28 At the beginning of each new reading the signal integrate line goes true. This enables the signal switch driver which closes the FET signal switch at the input to the integrator. The integrator begins to ramp up or down, depending on the polarity of the input signal. (See the preceding section on the operation of the integrator.) The signal integration ramp of the integrator continues until the counter reaches 99999 and resets to 00000. At the moment the counter resets to 00000, the 80,000 line (which went true when the counter

reached 80,000) goes false. This toggles the control flip flop and the signal integrate line goes false. The signal integrate line going false disables the signal switch driver and the FET signal switch opens.

4B.29 The polarity decision is made at the moment the counter resets from 99999 to 00000. If the input signal to the integrator is positive, the output voltage from the Integrator at the end of the signal integration time is negative. This causes the output voltage from the Null Detector to also be negative. This level is inverted by inverter J, setting the positive polarity line true (positive). The true level of the positive polarity line is inverted by inverter K, setting the negative polarity line false. If the polarity of the input signal were negative, the converse would be true. In short, if the polarity of the input signal is positive, the positive polarity line will be true and the negative polarity line false at the end of the signal integration period. If the polarity of the input signal is negative, the positive polarity line will be false and the negative polarity line true at the end of the signal integration period. When the signal integrate line goes false at the time the counter overflows to 00000, the polarity flip flop toggles. The position taken by the polarity flip flop is determined by the state of the positive polarity line and the negative polarity line at the end of the signal integration period. If the input signal is of positive polarity, the positive polarity line is true and the negative polarity line false. This causes the Q side of the polarity flip flop to be set which enables driver U. Driver U lights the + polarity light. If the input signal is of negative polarity the positive polarity line is false and the negative polarity line is true. This causes the $\overline{Q}$ side of the polarity flip flop to be set which enables driver V. Driver V lights the - polarity light.

4B.30 During the signal integration period the signal integrate line is true. This holds the negative polarity flip flop and the positive polarity flip flop in a reset state. At the time the counter goes from 99999 to 00000 at the end of the signal integration period, one or the other of these flip flops will toggle, depending on whether the positive polarity line or the negative polarity line is true. If the positive polarity line is true, the positive polarity flip flop toggles, its Q output going true. This disables nor gate P, keeping the pos. ref. integrate line from going true when the signal integrate line goes false. Since the negative polarity flip flop did not toggle, its Q output is false. This enables nor gate N as soon as the signal integrate line goes false. When nor gate N is enabled, the neg. ref. integrate line goes true, enabling the neg. ref. switch driver. The neg. ref. switch driver closes the FET neg. ref. switch. At this point the reference integration period begins and the output voltage from the integrator begins to ramp back toward zero volts. Had the input signal being measured been of negative polarity, the positive polarity line would have been false and the negative polarity line true at the end of the signal integration period. This would have caused the negative polarity flip flop to toggle when the signal integrate line went false, leaving the positive polarity flip flop in a reset state. This would have enabled nor gate P, setting the pos. ref. integrate line true (rather than the neg. ref. integrate line) and closed the neg. ref. switch.

4B.31 At the moment the output voltage from the Integrator crosses zero (on the reference integration slope) the positive polarity line and negative polarity line change state. That is, whichever one was true goes false and whichever one was false goes true. This causes the remaining polarity flip flop (positive polarity flip flop or negative polarity flip flop) to toggle. Whichever one did not toggle at the beginning of the reference integration period will do so at the end. This causes both nor gates N and P to be disabled so both the neg. ref. integrate line and the pos. ref. integrate line go (or remain) false. This opens both FET reference switches. When both the positive polarity flip flop and the negative polarity flip flop are in the set state, which occurs at the end of the reference integration period, nor gate M is enabled and the reset line goes true. This level is inverted by inverter Y and the $\overline{\text{reset}}$ line goes false. This holds the output of the integrator at a level of zero volts.

4B.32 When the reset line goes true at the end of the reference integration period, the strobe flip flop is actuated through or gate E. This causes the Q output of the strobe flip flop to go true which

actuates the strobe generator which is a 10 microsecond one shot. The strobe generator causes the strobe line to go true for a 10 microsecond period. This is inverted by inverter A and causes the $\overline{\text{strobe}}$ line to go false for a 10 microsecond period. Then the strobe line goes true, nor gate B is disabled, stopping the clock signals from reaching the counter for the duration of the strobe time. The negative level of the $\overline{\text{strobe}}$ line gates the buffer storage units which translate whatever levels exist at their inputs at that moment to their outputs. This information is stored at the outputs of the buffer storage units until the next negative transition of the $\overline{\text{strobe}}$ line at the end of the next reading. The levels at the inputs of the buffer storage units are the output of the counter. Since the transition of the $\overline{\text{strobe}}$ line which actuates the buffer storage units comes exactly at the end of the signal integration period, and at that time the state of the counter represents the value of the voltage being measured, the reading displayed by the instrument equals the value of the signal voltage.

4B.33 At the end of the 10 microsecond strobe time, the strobe line again goes false and the $\overline{\text{strobe}}$ line again goes true. When the strobe line goes false, nor gate B is again enabled and allows clock signals to reach the counter. The counter continues counting until it reaches 99999 whereupon it again resets itself to 00000. On this, the second transition of the counter from 99999 to 00000, the 80,000 line going false toggles the overrange flip flop but does not again toggle the control flip flop. (The overrange flip flop did not toggle on the first transition of the 80,000 line, at the end of the signal integration period, because both its S and C inputs were held true by the signal integrate line which was true at that time. The control flip flop does not re-toggle on the second transition of the 80,000 line because: a) the overrange flip flop, at that time has not yet toggled at all so its Q output is still false and its $\overline{\text{Q}}$ output is still true. b) the S and C inputs of the control flip flop are so connected that it cannot re-toggle until after the overrange flip flop does.) The counter continues to count until it again reaches a count of 99999 and resets itself to 00000. At this point the 80,000 line again makes a transition from true to false. This time both the overrange flip flop and the control flip flop toggle. The overrange flip flop is reset and the control flip flop is set, causing the signal integrate line to go true, which initiates a new reading.

4B.34 If the input signal voltage is greater than 99999, the overrange flip flop is set before the output voltage from the integrator reaches zero volts. As long as the input signal voltage is less than 11.9999V, which is the absolute maximum that the instrument will display, the instrument functions in exactly the same manner as outlined in the preceding paragraphs. The counter overflows to 00000 and begins counting up (to a maximum of 2000). When the zero crossing is detected the reset line goes true and toggles the strobe flip flop which triggers the strobe generator and the state of the counter at the moment of zero-crossing is read into the display. Since the overrange flip flop has been set, the 10,000 line is true at the time strobe is initiated. When the $\overline{\text{strobe}}$ line goes false the $\overline{\text{Q}}$ side of the overrange buffer storage unit goes false and the "1" digit is illuminated in the overrange (100,000's) window.

4B.35 Should the counter reach a count of 12,000 prior to the time the output voltage from the integrator reaches zero volts (input signal greater than 12,000V), both the $\overline{2000}$ line and the $\overline{10{,}000}$ line go false. This enables nor gate G whose output goes true setting the 12,000 line true. When the 12,000 line goes true it toggles the strobe flip flop through or gate E initiating the strobe pulse which causes the $\overline{\text{strobe}}$ line to go false, reading the momentary state of the counter (12,000) into the readout where it is stored by the buffer storage units until the next strobe occurrence. Since the 12,000 line is true when the $\overline{\text{strobe}}$ line goes false, the overrange buffer storage unit lights the overrange light through driver T. Upon the completion of the 10 microsecond strobe, the counter continues to count until it again overflows back to 00000. At this point a new reading is initiated with the resetting of the control flip flop at the negative going transition of the 80,000 line when the counter overflows. The output voltage from the null detector will reach zero sometime before the counter overflows as the signal input to integrator is limited to about $\pm$ 14 volts. If, for any reason, the counter reaches a count of 18,000 prior to zero detection, it stops and waits for zero detection at 18,000.

4B.36 TIMEOUT AND HOLD OPERATION

4B.37 During range-changing operations, the Digitizing and Display circuitry is inhibited from taking any new readings. This gives the analog circuits in the Signal Conditioning Module enough time to settle following range changes and prevents the display of erroneous readings. To accomplish this, the ranging circuitry (located in the Signal Conditioning Module) generates a 500 millisecond timeout pulse. During the timeout period, the timeout line into the Digitizing and Display Module goes true. If the instrument is not in hold (off-on-hold switch in the Hold Position) or operating in an external command mode (from the optional BCD output module), the hold line will be false. Normally, when the instrument is not going through a timeout period, the timeout line is also false. When the output voltage from the Integrator reaches zero volts, during the reference integration period, the reset line goes true setting the $\overline{\text{reset}}$ line false. This is inverted by nor gate X, setting the read enable line true. When the read enable line is true, nor gate H is inhibited and the counter is allowed to count to 19999 (the overrange flip flop has been set) and reset to 00000, thus beginning a new read cycle. When timeout occurs, however, the timeout line goes true, inhibiting nor gate X so the read enable line stays false. When the counter reaches a count of 18000, the $\overline{10{,}000}$ line and the $\overline{8000}$ line both go false. At this point, all inputs to nor gate H are false and the gate is enabled, setting the read disable line true. When the read disable line goes true it disables nor gate B, preventing any further clock signals from reaching the counter, so the counter stops at 18000. At the conclusion of the timeout period, the timeout line goes false enabling nor gate X. This sets the read enable line true disabling nor gate H. At this point the read disable line goes false enabling nor gate B to pass clock signals to the counter. The counter continues counting until it reaches 19999, whereupon it overflows and a new reading begins.

4B.38 When the off-on-hold switch is placed in the hold position, the hold line goes true. This stops the counter at 18,000, in exactly the same manner as when the timeout line goes true. The difference is that the instrument remains that way until the switch is returned to the on position. At that time the instrument resumes normal operation just as it does when the timeout pulse ends.

4B.39 Instruments equipped with the BCD output module (optional) may be operated in an external command mode. In this way they can be programmed to take a reading only upon receiving a signal to do so from an external device, such as a computer. When an instrument is in this mode of operation the external command line into the Digitizing and Display Module is normally held in a false state. The instrument is placed in hold either by the front panel hold switch or by the external hold line (not shown on figure 4B.1). When an external "read command" is initiated, the external command line goes true setting the hold line false. The instrument takes a reading just as it does upon the completion of a timeout pulse.

4B.40 RANGING

4B.41 In order to facilitate automatic ranging operation, uprange and downrange signals are generated by the Digitizing and Display Module. These signals command the range counter in the Signal Conditioning Module to count up or down. If the instrument is in too low a range for the signal voltage being measured the counter will reach a full scale count of 120,000 prior to the zero-crossing of the output voltage of the integrator on the reference integration period. When this occurs, the 120,000 line goes true initiating strobe action. When this happens, the $\overline{120{,}000}$ line (which is normally always in a true state) goes false. If the instrument is not already in the highest range, the highest range line into the Digitizing and Display Module will be false. This enables nor gate M3-3 setting the uprange line true. If the instrument is in too high a range for the signal being measured, null detection (and subsequently strobe) will occur before the counter reaches a count of 1000. This means that at the time strobe occurs the 1000 line is still false. If the instrument is not already in the lowest range the downrange flip flop remains in a reset state. Its $\overline{Q}$ side is true setting the downrange line true. If the instrument is already in the lowest range the lowest range line is true. This causes the downrange flip flop to be "set" as soon as the

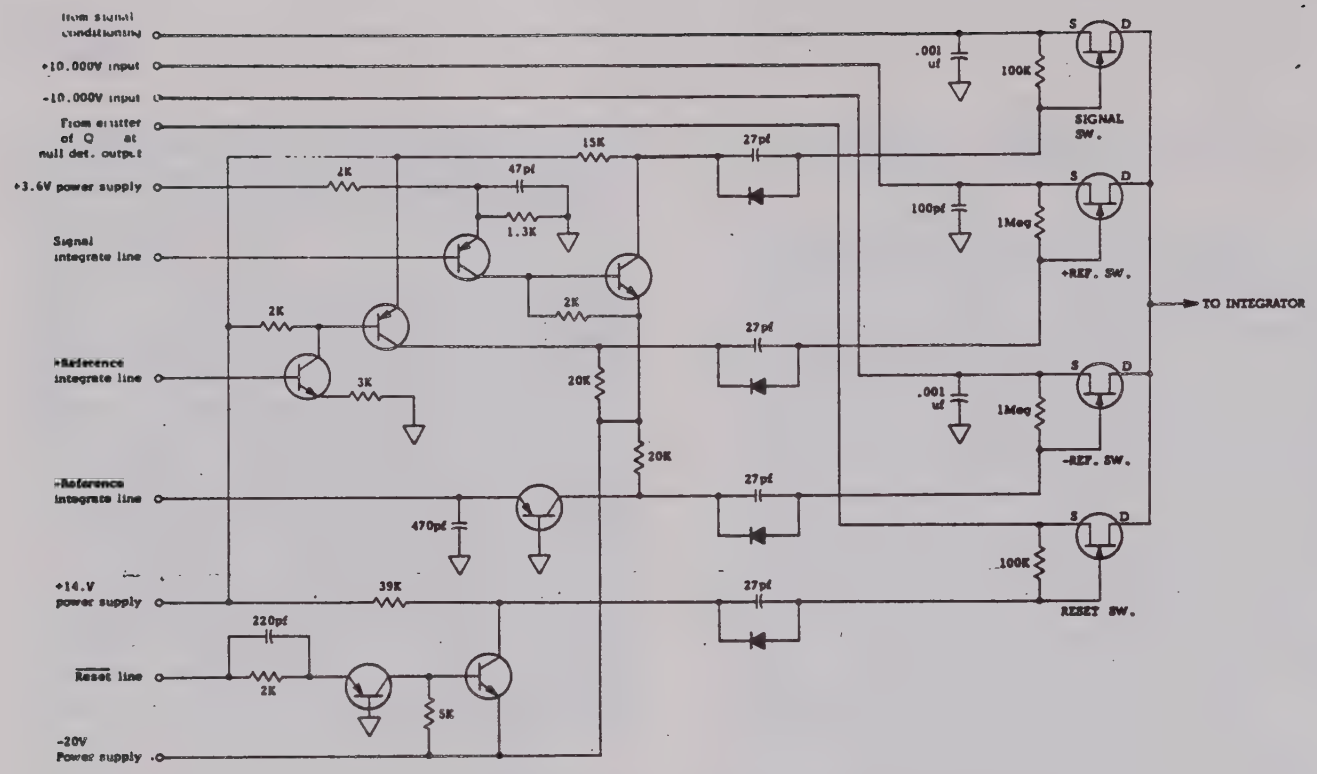


Figure 4B.9 - Schematic, FET switches and switch drivers

signal integrate line goes false at the end of the signal integrate period. When the downrange flip flop is "set" its Q side is false causing the downrange line to be false. Whenever the count of the counter is between 1000 and 12,000 at the time the Integrator zero-crossing occurs the 1000 line is true so the downrange flip flop is "set", resulting in no downrange signal and the 12,000 line is true, resulting in no uprange signal.

4B.42 FET SWITCHING CIRCUITRY

4B.43 The four switches at the input to the Integrator are N-channel, field-effect, junction transistors. They are driven by circuitry composed of discrete components. The FET switches and their driving circuitry are shown in figure 4B.9. The source and gate of each FET are connected to each other through fairly high value resistors (100K or 1 Meg). The gate of each FET connects to the driving circuitry through a series diode whose cathode connects to the collector of the driving transistor.

4B.44 In operation, the field-effect transistors are fully cut off (switch open) when the voltage at the gate, with respect to the source, is approximately -6V or more (-6V negative bias). When a FET is turned off, its driving transistor is either fully saturated (as is the case with the signal integrate switch and the reset switch) or fully turned off (as is the case with the + Ref Sw. and the - Ref Sw.). In either case the net effect places its collector voltage at -20V. Since the cathode of the diode which connects to the gate of the FET is connected to the driver transistor's collector it too is at a -20V potential. Under this condition, the diode is forward biased. Current flows through the resistor which is connected between the source and gate of the FET. This produces a voltage drop across the resistor which places the FET's gate voltage at nearly -20V. Since no input signal to any of the FET switches is more negative than about -14V (under overload conditions) this assures that the FET is completely cut off.

4B.45 When a FET is turned on (switch closed) its driver transistor's collector goes positive (relative to the most positive voltage that appears at the source of that particular FET). This causes the diode to be back biased so no current flows through it. Under this condition no current flows through the resistor connected between the source and gate of the FET so the source and gate are at the same potential (zero volts bias).

SECTION 4C

THEORY OF OPERATION OF THE POWER SUPPLY MODULE

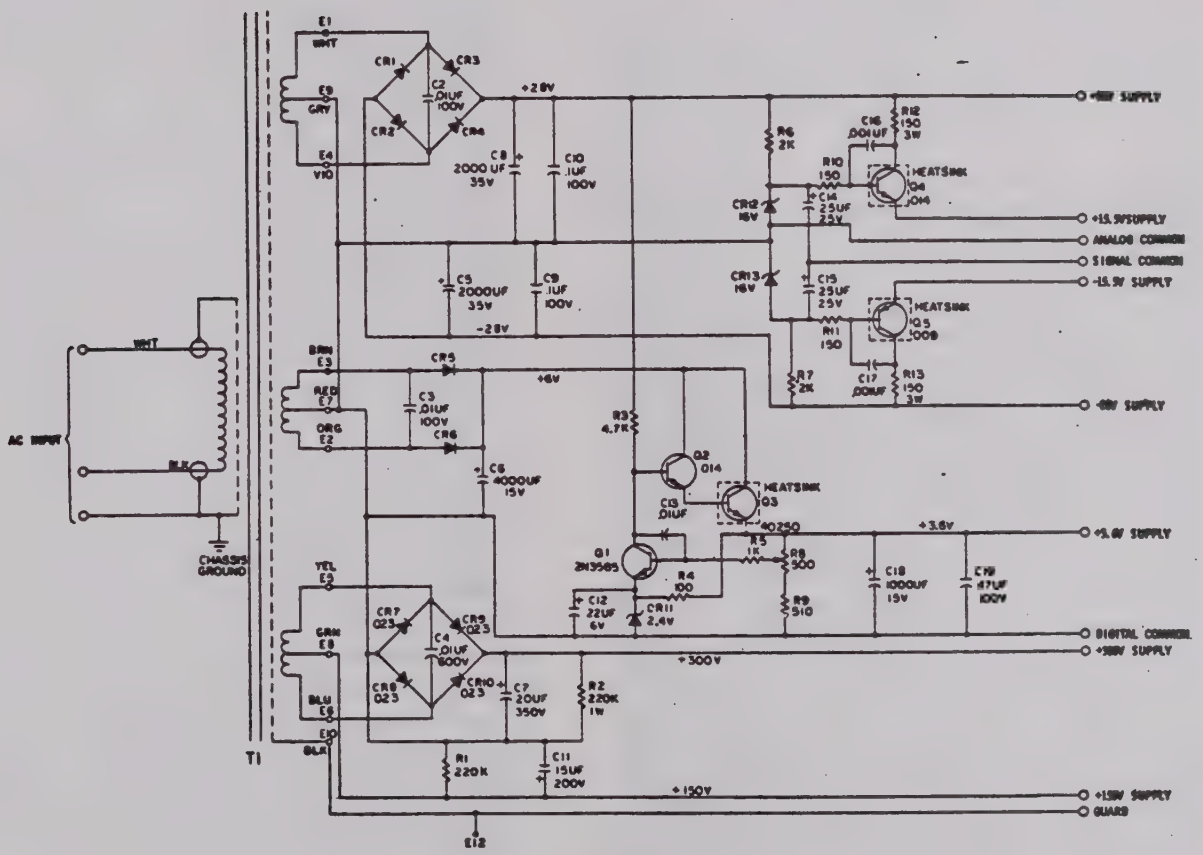


Figure 4C.1 - Power Supply

4C.1 INTRODUCTION

4C.2 The Power Supply Module, shown in detail in the schematic diagram section at the back of this manual, performs two distinct functions. It provides all DC operating power to the instrument and it serves to interconnect the Digitizing and Display Module and the Signal Conditioning Module. It is constructed on a single printed circuit board. Both the Digitizing and Display Module and Signal Conditioning Module plug into sockets on the Power Supply Module.

4C.3 POWER SUPPLY

4C.4 The Power Supply, shown in figure 4C.1, provides DC power to both the analog and digital

portions of the instrument. Seven different voltage levels are provided. These are:

+28V	unregulated
-28V	unregulated
+15.5V	regulated
-15.5V	regulated
+3.6	regulated
+300V	unregulated
+150V	unregulated

The power transformer has three secondary windings which step the AC line voltage to three different levels. The 300V winding provides power for the +300V and +150V supplies. The 6V winding supplies power for the +3.6V supply and the 56V winding provides power for the positive and negative 28V and 15.5V supplies.

4C.5 Diodes CR-7 through 10 form a full wave bridge type rectifier whose input is connected across the 300V winding of the power transformer. The output of the bridge rectifier is connected across capacitor C7 which is the filter capacitor for the +300V line. Resistor R2 is connected across capacitor C7 as a bleeder resistor to eliminate shock hazard. The +150V DC output is taken from the center tap of the 300V transformer winding. Capacitor C11 is the filter capacitor for the +150V DC line. Resistor R1 is the bleeder resistor for capacitor C11.

4C.6 Diodes CR-1 through 4 are shown on the schematic diagram connected across the 56V transformer winding as a bridge. In operation, however, they do not function in exactly the same manner as a conventional full wave bridge rectifier. The winding is center tapped and this point is connected to digital common (ground). Diodes CR-3 and CR-4 form a full wave rectifier which charge capacitor C8 to +28V DC. C8 is connected between the +28V line and digital common and is the +28V filter capacitor. Similarly, diodes CR-1 and CR-2 form a full wave rectifier which charges capacitor C5 to -28V DC. C8 is connected between the -28V line and digital common and is the filter capacitor.

4C.7 Transistors Q4 and Q5 are series regulators which reduce the +28V to +15.5V and -28V to -15.5V respectively. Zener diodes CR-12 and CR-13 clamp the bases of these transistors at a 16V level. The voltages at the emitters of these transistors are always about 0.6V less than that at the bases and since the voltage at the bases is clamped by the zeners the 15.5V lines are regulated. Resistors R12 and R13, in series with the collectors of the regulator transistors, provide protection for the transistors in the event of an accidental short circuit between either 15.5V supply line and circuit common. The digital, analog and signal commons all connect together in the Signal Conditioning Module. Capacitors C14 and C15 filter zener noise and keep it off the 15.5V lines.

4C.8 The 6V winding of the power transformer is connected to circuit common. Diodes CR-5 and CR-6 and the center tap of the winding form a full wave rectifier which charges filter capacitor C6. In operation the voltage across capacitor C6 is approximately +6V DC with respect to circuit common. Transistor Q3 is a series regulator transistor which converts the +6V to +3.6V. Transistors Q2 and Q3 are connected in a Darlington configuration. The current gain of Q3 is thus multiplied by the current gain of Q2. Base drive for the Darlington connected regulator transistors is provided by resistor R3 which connects to the +28V line. It is controlled by the collector current through transistor Q1. Base bias for transistor Q1 comes through resistor R5 which connects to the wiper of potentiometer R8. Zener diode CR-11 clamps the voltage at the emitter of transistor Q1 at +2.4V. This forces the voltage at Q1's base to always be approximately +3V. This causes any voltage change at the wiper of potentiometer R8 to result in a directly proportional change in the current through resistor R5. Since this is the current controlling transistor Q2, the zener acts as a reference element which stabilizes the output voltage of the supply. Potentiometer R8 is adjusted to set the collector current through transistor Q1. The potentiometer is adjusted to a point to give enough base drive to the Darlington circuit to keep the emitter voltage of transistor Q3 at exactly +3.6V. If the voltage at the emitter of Q3 should drop (due to a change in either the line voltage or level current) the available base drive to transistor Q1 will also decrease. This will cause less collector current to flow through transistor Q1. More current is available as base drive for the regulator transistors. This current turns transistor Q3 on harder and raises the emitter voltage back to +3.6V.

SECTION 4D
THEORY OF OPERATION
ELECTRICAL OUTPUT MODULE

4D.1 INTRODUCTION

4D.2 The BCD Output Module, shown in detail in the schematic diagram section at the back of this manual and in simplified form in figure 4D.1, is an optional feature which plugs into the rear of the instrument. It allows the instrument to be used as part of a larger digital system. The module provides BCD outputs of function, range, and the state of the readout. In addition, a print command output is provided for use with digital printers and it accepts a "read" command to begin a new reading.

4D.3 LOGIC LEVEL OF BCD OUTPUT

4D.4 The voltage level of the positive true output is +3.6 volts delivered through a 640Ω resistor. The false level is near zero volts (figure 4D.1).

4D.5 RANGE CODING

4D.6 The instrument is equipped with five operating ranges, 1 through 10,000 (although not all ranges are used for all functions). Coding for the range in use at any given time is brought out on three lines. These are designated the R_1, R_2, and R_3 lines. The state of these lines for each range is given in table 4D.1.

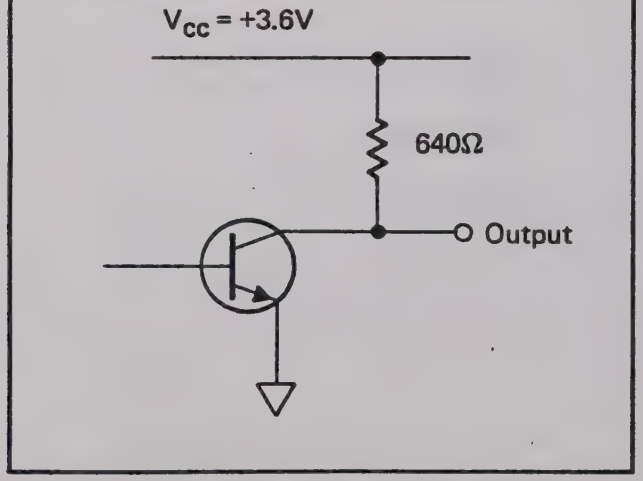


Figure 4D.1 - Typical Output Circuit

TABLE 4D.1

Range	R_1	R_2	R_3	BCD Value
1	True	False	True	5
10	False	False	True	4
100	True	True	False	3
1000	False	True	False	2
10,000	True	False	False	1

4D.7 POLARITY

4D.8 A single line is brought out of the BCD Output Module carrying polarity information. This is designated the – POLARITY OUTPUT line.

4D.9 When the instrument is operated in the "external read command" mode, the off-on-hold switch on the front of the instrument must be in the "hold" position. If this is not done the instrument will continue taking readings automatically every 300 milliseconds.

4D.10 Resistors R3 and R4 bias the read command line at 3.5 volts. Thus the line is normally always in a "true" state. The one millisecond delay on figure 4D.1 is caused by the charging time required for capacitor C3. The one-millisecond one-shot shown on figure 4D.1 is comprised of resistor R1, capacitor C1, diode CR1, and 1/2 of M4. The command flip flop is comprised of one half of M2 (A & B). Resistor R3 and zener diode CR3 protect the input of inverter M4-C from overload damage if an excessive voltage is applied to the READ COMMAND INPUT.

4D.11 When an externally commanded reading is initiated, the READ COMMAND INPUT is grounded, setting the read command line false. This causes the output of M4-C to go true which appears as a true input to OR M4-B after a one millisecond delay (to prevent false triggering due to noise or "bouncing" switch contacts). A one millisecond pulse is generated. This pulse sets the command flip-flop causing its Q output to go true. This sets the external command line true, which causes the instrument to take a reading.

4D.12 If, during the process of taking a reading, a range change is involved, the timeout line will be set true, the command flip flop is not reset, and the instrument continues taking readings until the correct range is found.

05 OPTION
PIN CONNECTIONS

IDENTIFICATION		PINS J20		IDENTIFICATION	
RANGE	R1	1	26	R3	RANGE
RANGE	R2	2	27	R4	RANGE
FUNCTION	F2	3	28	F4	FUNCTION
FUNCTION	F1	4	29	F3	FUNCTION
UNITS	X1	5	30	X3	UNITS
UNITS	X2	6	31	X4	UNITS
10'S	X1	7	32	X3	10'S
10'S	X2	8	33	X4	10'S
100'S	X1	9	34	X3	100'S
100'S	X2	10	35	X4	100'S
1000'S	X1	11	36	X3	1000'S
1000'S	X2	12	37	X4	1000'S
10,000'S	X1	13	38	X3	10,000'S
10,000'S	X2	14	39	X4	10,000'S
100,000	X1	15	40		
		16	41		
OVERLOAD	X1	17	42	X3	OVERLOAD
OVERLOAD	X2	18	43	X4	OVERLOAD
		19	44		
		20	45		
		21	46	$\overline{\text{READ COMMAND INPUT}}$	
		22	47		
		23	48	$\overline{\text{PRINT COMMAND}}$	
LOGIC COMMON		24	49		
+ LOGIC REFERENCE		25	50	LOGIC COMMON	

MODEL 05 OUTPUT OPTION													Binary Weight
J20 Pin No's	1	2	26	27*	4	3	29	28*	17	18*	42*	43*	
RANGE 0.1	0	1	1	0									6
RANGE 1	1	0	1	0									5
RANGE 10	0	0	1	0									4
RANGE 100	1	1	0	0									3
RANGE 1000	0	1	0	0									2
RANGE 10,000	1	0	0	0									1
FUNCTION OHMS					0	0	0	0					0
FUNCTION AC					1	0	0	0					1
FUNCTION –					1	1	1	0					7
FUNCTION +					1	0	1	0					5
OVERLOAD									1	0	0	0	1
NO OVERLOAD									0	0	0	0	0
CODE	1	2	4	8	1	2	4	8	1	2	4	8	

*Strapped to Common

SAMPLE DATA VALUES

	100K	10,000				1000				100				10				UNITS			
J20 Pin No's	15	13	14	38	39	11	12	36	37	9	10	34	35	7	8	32	33	5	6	30	31
000001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
000007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0
000014	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0
000101	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
001246	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	1	1	0
120000	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Code	1	1	2	4	8	1	2	4	8	1	2	4	8	1	2	4	8	1	2	4	8

0 = FALSE

1 = TRUE

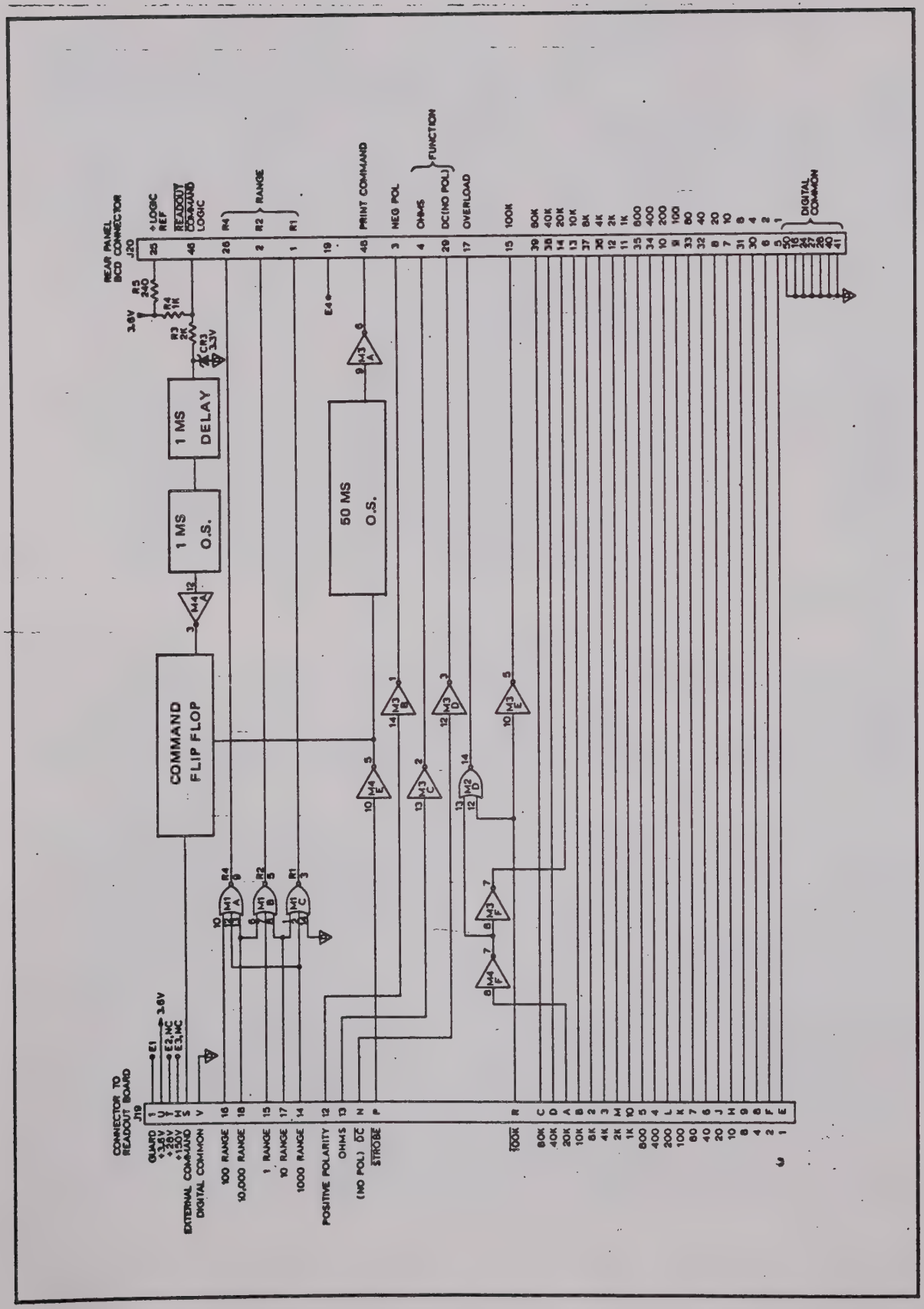


Figure 4D.2 - BCD Output Module, Simplified Schematic

SECTION 5

CALIBRATION

5.1 INTRODUCTION

5.2 This calibration procedure is designed to keep the model 5200-550 DMM operating within its specifications. Any necessary maintenance should be done prior to calibration. The calibration steps in this procedure rely on the adjusted accuracy of the preceding step, therefore care must be taken to make each adjustment in the order that it appears in this procedure.

5.3 EQUIPMENT REQUIRED

5.4 The following equipment, or an acceptable equivalent, is required for DMM calibration and is listed in the order of use. The test equipment specifications listed are recommended by Dana as necessary to give satisfactory calibration.

I. Basic DC Calibration of the Instrument

(a) A precision DC voltage standard (calibrator) variable from 0 to 1000 volts having a resolution of 10 microvolts or better at 10 volts (1 PPM), and an accuracy of .0005% with a stability of .0003%. For example, the Fluke model 332A or the Cohu model 351.

(b) A guarded absolute ratio voltbox capable of precision voltage division of 100:1, 10:1 and 1:1 with a resolution of ½ part per million. The input resistance should be 50 kilohms, minimum, at a ratio of 10:1 and 500 kilohms, minimum, at a ratio of 100:1. An ESI model 1040 A is recommended. (This instrument, when used in conjunction with the DC standard and a standard cell traceable to N.B.S., can normalize the DC standard to the traceable source).

(c) A precision decade voltage divider capable of 10:1 and 100:1 division, having an input resistance of 10,000 ohms minimum, an output resistance of 5000 ohms maximum, and an accuracy of .005% or better. For example, the ESI model RV-622A.

(d) A one megohm 5% carbon resistor.

II. AC Calibration (required only if the instrument has the AC option)

(a) An AC laboratory power source, variable from 0 to 500 volts and 50 Hz to 10 kHz, having a resolution better than 100 PPM, harmonic distortion of 0.1% or less and a stability of .01%. For example, the Optimation type AC 110, (oscillator, matching transformer, and power amplifier).

(b) An AC/DC laboratory transfer standard (for calibration of the AC source) having an accuracy of .05% or better. For example, the Holt Model 6 Thermal Transfer Voltmeter.

III. Ohms Calibration (required only if the instrument has the OHMS option.)

(a) Standard resistors: 1K, 10K, 100K, and 1 Megohm with value known to within .005%; and a 10 Megohm with value known to within .01%. For example, the ESI SR 1 series standard resistors.

5.5 TOOLS

(a) An insulated blade-type calibration tool.

(b) A No. 1 Phillips screwdriver.

5.6 PREPARATION

(a) Remove the two screws which secure the top and bottom covers of the instrument. Slide only the top cover back and remove it.

(b) Set the DMM controls as follows:

Function: DC volts
Range: Auto
Ext Ref Switch (on rear panel): Out (if applicable)

(c) Set the OFF-ON-HOLD switch on the front of the instrument to the ON position.

(d) Connect the GUARD terminal on the front of the instrument to the LO input terminal. Connect a test lead to the HI input terminal of the instrument.

5.7 POWER SUPPLY CHECK (Refer to Figure 5.2)

(a) Using the test lead installed in the preceding step (5.6-d), the instrument can measure its own operating voltages at the four test points listed below. If any of the voltages do not measure within the tolerances indicated the defective power supply must be repaired before any further calibration is attempted. (NOTE: The uncalibrated accuracy of the instrument is normally adequate for measuring these voltages within the specified limits unless the unit in need of repair.)

Test Point	Voltage
I	+15 volts ± 10%
Z	-20 volts ± 10%
T	-15 volts ± 10%
1	+3.6 volts ±0.1 volt (If not within tolerance, adjust potentiometer R-8 on the Power Supply Module to set the voltage to +3.6 volts)

(b) Remove the test lead from the "HI" input terminal.

(c) Short the "HI" and the "LO" input terminals of the instrument together. (NOTE: This clip lead must use plain, unplated copper clips. Cadmium plated clips act like thermocouples, generating enough voltage to cause several digits of zeroing error in some cases.)

(d) Replace the top cover on the unit and allow at least 30 minutes for the instrument to reach a stable internal ambient operating temperature.

5.8 ANALOG ZERO ADJUSTMENT

(a) Jumper the "High" and "Low" Input Terminals together. Select the 10 Range and place the instrument in the DC Function. Carefully note the reading displayed by the instrument.

(b) Place the instrument in the 1 Volt Range. Adjust the front panel Zero Offset (R35) potentiometer to obtain a reading within ± 1 digit of the reading noted in step "a" above.

(c) Remove the jumper between the "High" and "Low" Input Terminals and place a 1 meg ohm ¼ Watt carbon resistor between the "High" and "Low" Input Terminals. Verify that the display is the same as step "a" ± 1 digit. If the display is greater than ± 2 digits proceed with steps "d" thru "i".

(d) Move the cover toward the rear of the DMM to allow access to the Isolator Current Zero adjustment R26.

(e) Connect a microvoltmeter to the Analog Output Terminals on the rear of the DMM. If the DMM is not equipped with external analog output, the top cover will have to be removed. Connect the microvoltmeter to TP3 on the display board. Refer to figure 5.1 or 5.2. Connect the microvoltmeter common to TP2. Slide the top cover on the DMM and allow five minutes for temperature stabilization before proceeding with the

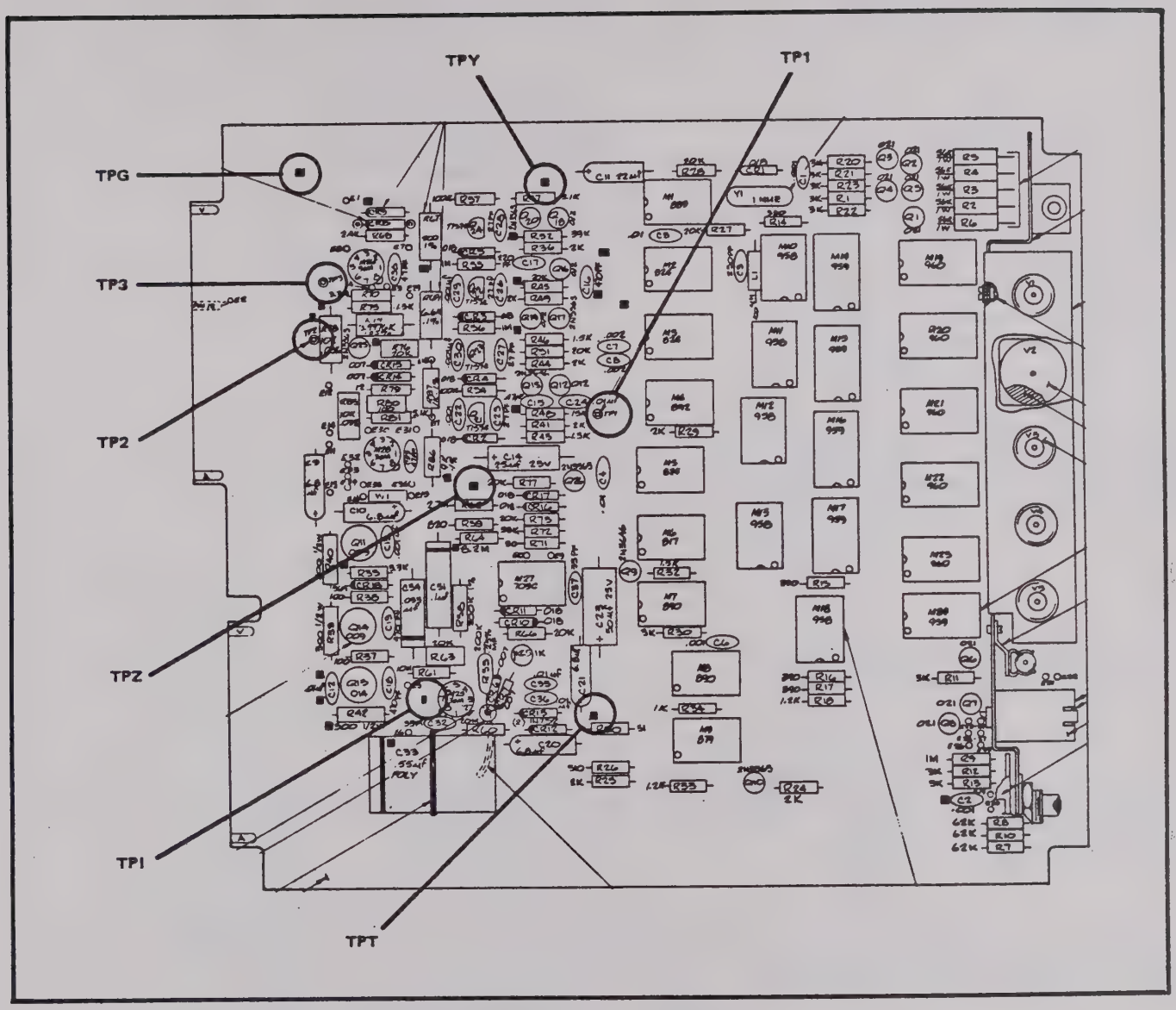


Figure 5.2 - Test Points

Test Point	Voltage
TP- I	+ 15V ± 10%
Z	- 21.6V ± 10%
T	- 15V ± 10%
Y	+ 3.6V ± .1V
G	+ 300V ± 10%
X	+ 150V ± 10%
3	Analog Signal
2	Common

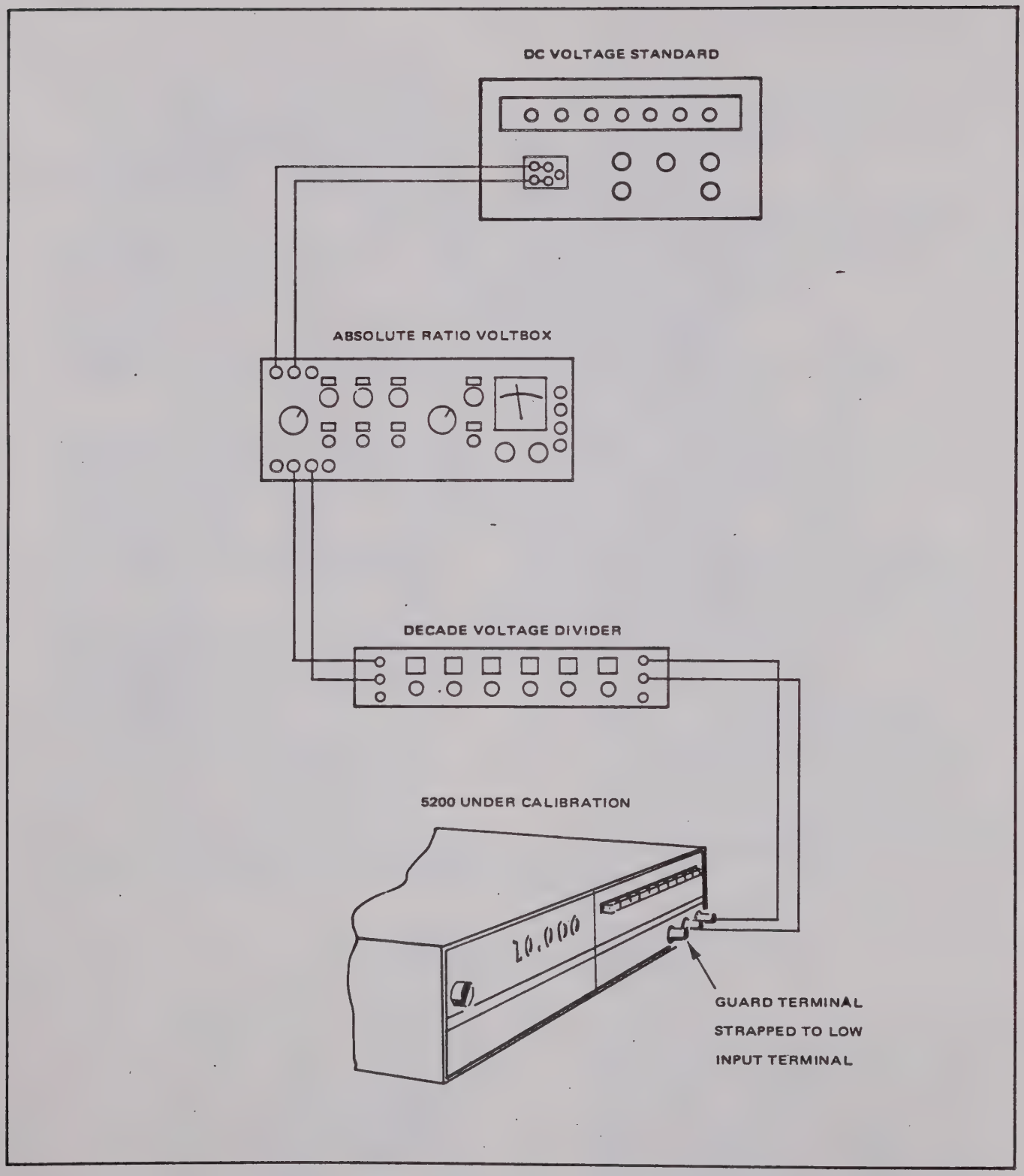


Figure 5.3 - Setup for calibration of lower DC voltage ranges

next step. Route the microvoltmeter cable toward the front of the DMM display board and out to the microvoltmeter.

(f) Short the 1 megohm resistor with a jumper.

(g) Place the DMM in the 10 Range. Note the reading on the microvoltmeter.

(h) Place the DMM in the 1 Range. Adjust the zero offset pot R35 for the same reading as in step "g" ± 30 microvolts.

(i) Place the DMM on its left side. Slide the bottom panel back to adjust the Current Zero Control R26. The Current Control is located on the bottom side of the Analog Drawer. Refer to figure 5.1b.

(j) Remove the jumper across the 1 megohm resistor at the input terminals. Adjust the Current Zero Control R26 for the same reading as in step "g" ± 30 microvolts. This completes the voltage and current zero of the Isolator. Remove the 1 megohm resistor and install both covers.

5.9 INTEGRATOR ZERO ADJUSTMENT

(a) Jumper the input terminals together on the front panel. Place the DMM in the DC Function and the 10 Range. Allow the DMM five minutes warm up.

(b) Slide the top cover to the rear of the DMM to expose the Integrator Zero Adjustment Control R-63. Refer to figures 5.1 and 5.2 for location.

(c) Adjust the Integrator Zero Control R-63 such that the Polarity Indicators are alternately displaying plus and minus.

(d) Remove the short between the "High" and "Low" Input Terminals.

(e) Connect the test equipment and the instrument under calibration as shown in figure 5.3. Connect the test leads from the decade voltage divider to the DMM. Connect the input voltage to the DMM with the negative tied to the "High" Input Terminal of the DMM.

(f) Apply an input voltage of -0.001 VDC to the DMM. Note the reading. Apply an input voltage of +0.001 VDC. Note the second reading and compare with the first reading. If the adjustment of the integrator zero control is correct the voltage in both cases will be the same but the polarity will change with the input polarity. Adjust the Null Detector Control (R65) on the display board for a display of 10 digits or 1 millivolt. Verify that the DMM reads + or — 1 millivolt with the signal on the input. Also verify that the DMM displays alternately plus and minus and all zeros with the input shorted. If necessary, repeat steps 5.9 (a) thru (f).

5.10 VOLTAGE CALIBRATION OF THE PLUS AND MINUS REFERENCE SUPPLIES

(a) Set the absolute ratio voltbox to 1.0.

(1:1) Set the decade voltage divider to .999995. This will apply an input signal of -9.99995 volts to the DMM.

(b) Remove the top cover to expose the Negative Full Scale Adjustment Control R76.

(c) Adjust the Negative Full Scale Adjustment Control for a reading of -9.9999 bouncing -10.0000.

(d) Place the top cover on the DMM. Allow five minutes for the DMM to stabilize. Verify that the DMM reads -9.9999 bouncing -10.0000.

Note: Digital Multimeters with Ratio Option (04), follow steps (i) thru (o). Digital multimeters without Ratio Option, follow steps (e) thru (h).

(e) Reverse the polarity of the input signal to +9.99995 volts.

(f) Remove the top cover and adjust the Positive Full Scale Control R80 for a reading of +9.9999 bouncing +10.0000.

(g) Place the top cover on the DMM. Allow five minutes for the DMM to stabilize. Verify that the DMM reads +9.9999 bouncing +10.0000.

(h) Verify that the indication on the instrument readout will "bounce" between +9.9999 and +10.0000 with an input signal of from +9.99994 to +9.99996 volts. If necessary, repeat the adjustments of the Negative Full Scale Control R76 and the Positive Full Scale Control R80 outlined in steps 5.10a through 5.10g to obtain the specified readings.

(i) Place the DMM in the Ratio function by depressing the Ratio X10 push button on the rear panel.

(j) Place a jumper between reference Common and Reference Input terminals on the rear panel.

Note: This shorts the input to the Negative Reference Supply.

(k) Remove the top cover and connect a microvoltmeter to TPK on the display board. Refer to figure 5.1. Connect the microvoltmeter common to TP2.

(l) Adjust the Negative Reference Zero R84 for zero ± 30 microvolts.

(m) Place the cover on the DMM and allow five minutes for the DMM to temperature stabilize. Verify that the Negative Reference Supply remains zero, ± 30 microvolts.

(n) Remove the jumper from the Reference Common and Reference Input terminals. Depress the Ratio X10 button for normal operation. Remove the microvoltmeter leads, and place the top cover on the DMM.

(o) Proceed with steps (e) thru (h).

5.11 LINEARITY TEST (NOTE: There are no adjustments to be made in section 5.11. These tests are included to verify the overall accuracy of the instrument up to this point.)

(a) Set the DMM controls as follows:

Function: DC
Range: 10
Ratio X10 Switch (on rear panel): Out (If applicable)

(b) Verify the DMM readout for the following input voltages:

Voltage Input	DMM Readout
-11.99500	-11.9950 ± 2 digits
-10.00000	-10.0000 ± 2 digits
- 9.00000	- 9.0000 ± 2 digits
- 8.00000	- 8.0000 ± 2 digits
- 7.00000	- 7.0000 ± 2 digits
- 6.00000	- 6.0000 ± 2 digits
- 5.00000	- 5.0000 ± 2 digits
- 4.00000	- 4.0000 ± 2 digits
- 3.00000	- 3.0000 ± 2 digits
- 2.00000	- 2.0000 ± 2 digits
- 1.00000	- 1.0000 ± 2 digits
0.00000	+0.0000 ± 2 digits

(c) Reverse the polarity of the input to the DMM and verify the readout for the following input voltages:

Voltage Standard Input	DMM Readout
+ 1.000000	+ 1.0000 ± 2 digits
+ 2.000000	+ 2.0000 ± 2 digits
+ 3.000000	+ 3.0000 ± 2 digits
+ 4.000000	+ 4.0000 ± 2 digits
+ 5.000000	+ 5.0000 ± 2 digits
+ 6.000000	+ 6.0000 ± 2 digits
+ 7.000000	+ 7.0000 ± 2 digits
+ 8.000000	+ 8.0000 ± 2 digits
+ 9.000000	+ 9.0000 ± 2 digits
+ 10.00000	+10.0000 ± 2 digits
+ 11.99950	+11.9995 ± 2 digits
0.000000	0.0000 ± 2 digits

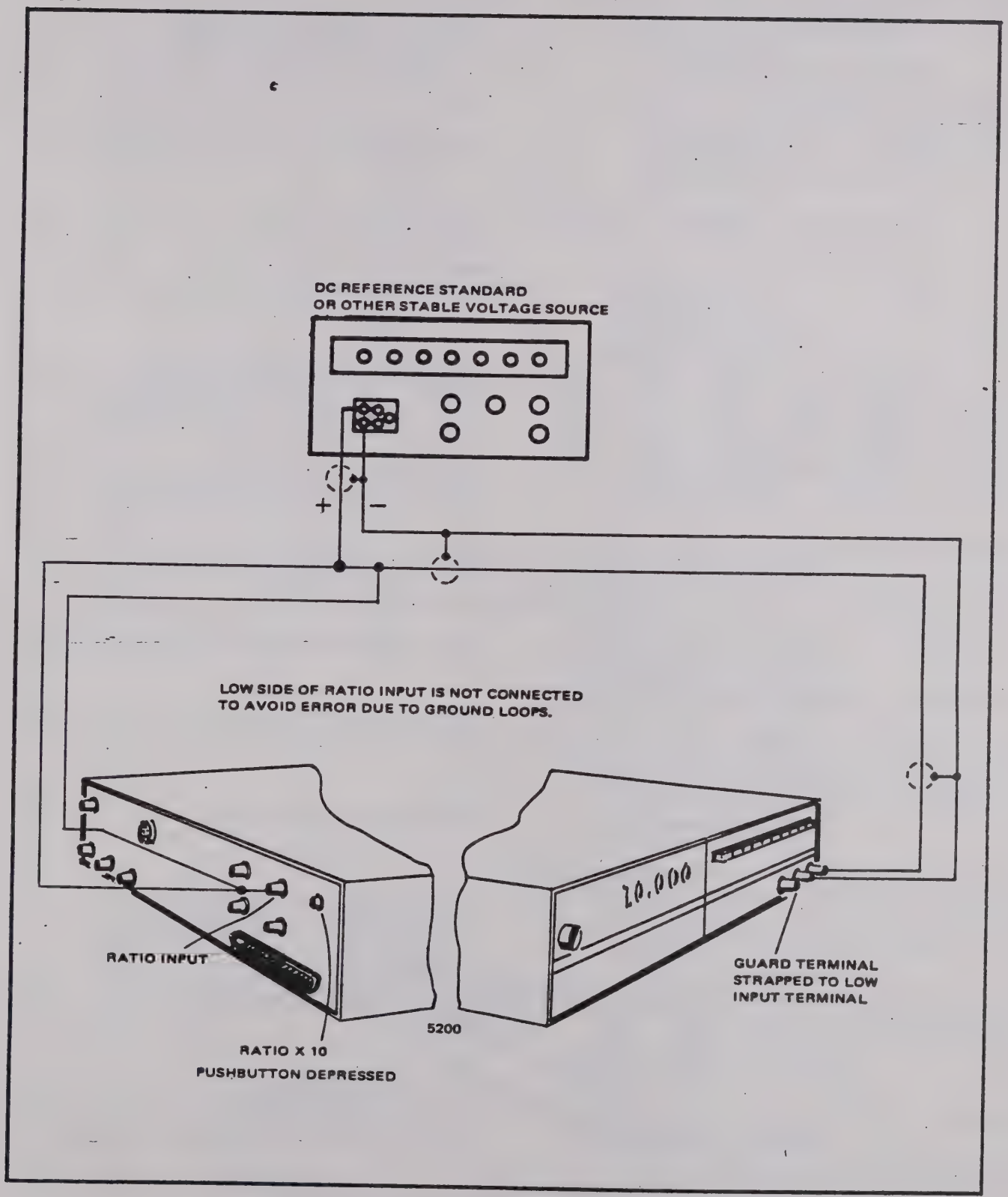


Figure 5.4 - Ratio measurement accuracy test setup

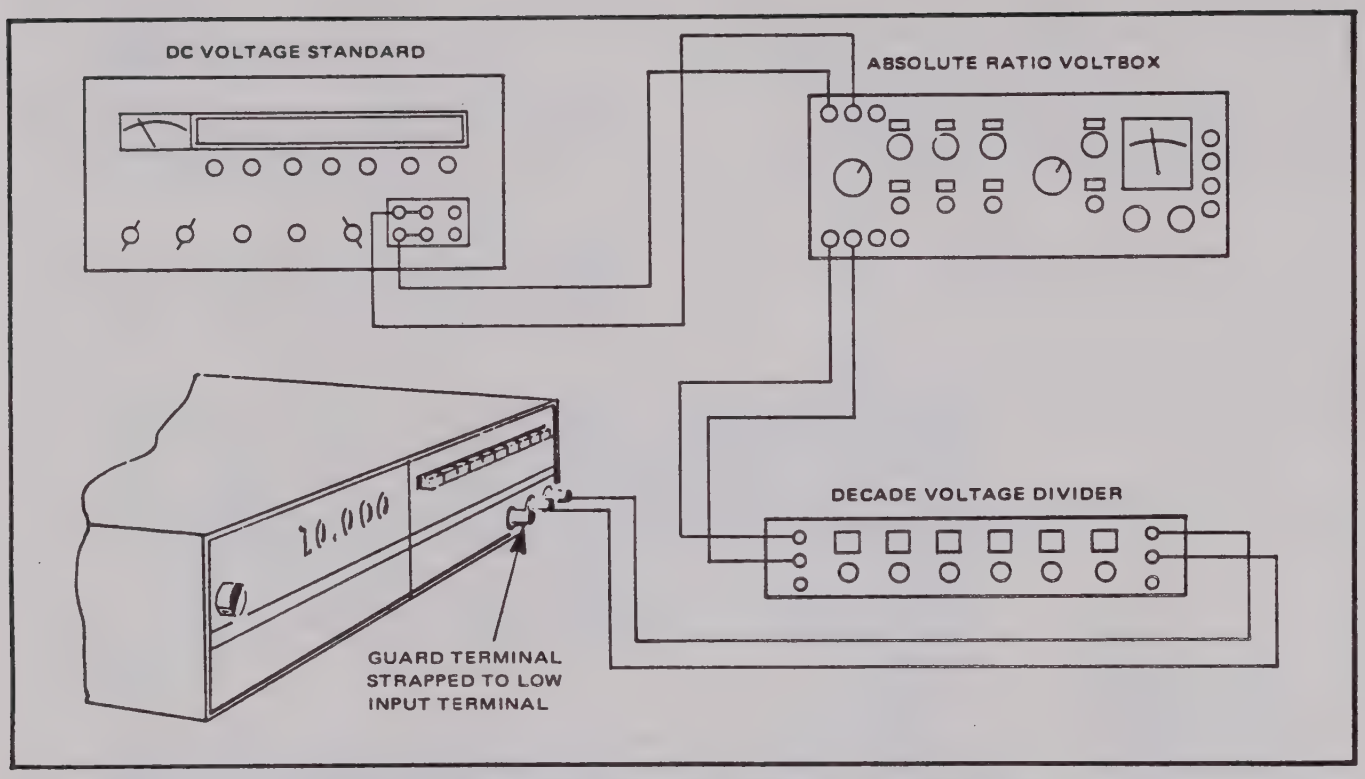


Figure 5.5 - Setup for calibration of lower DC voltage ranges

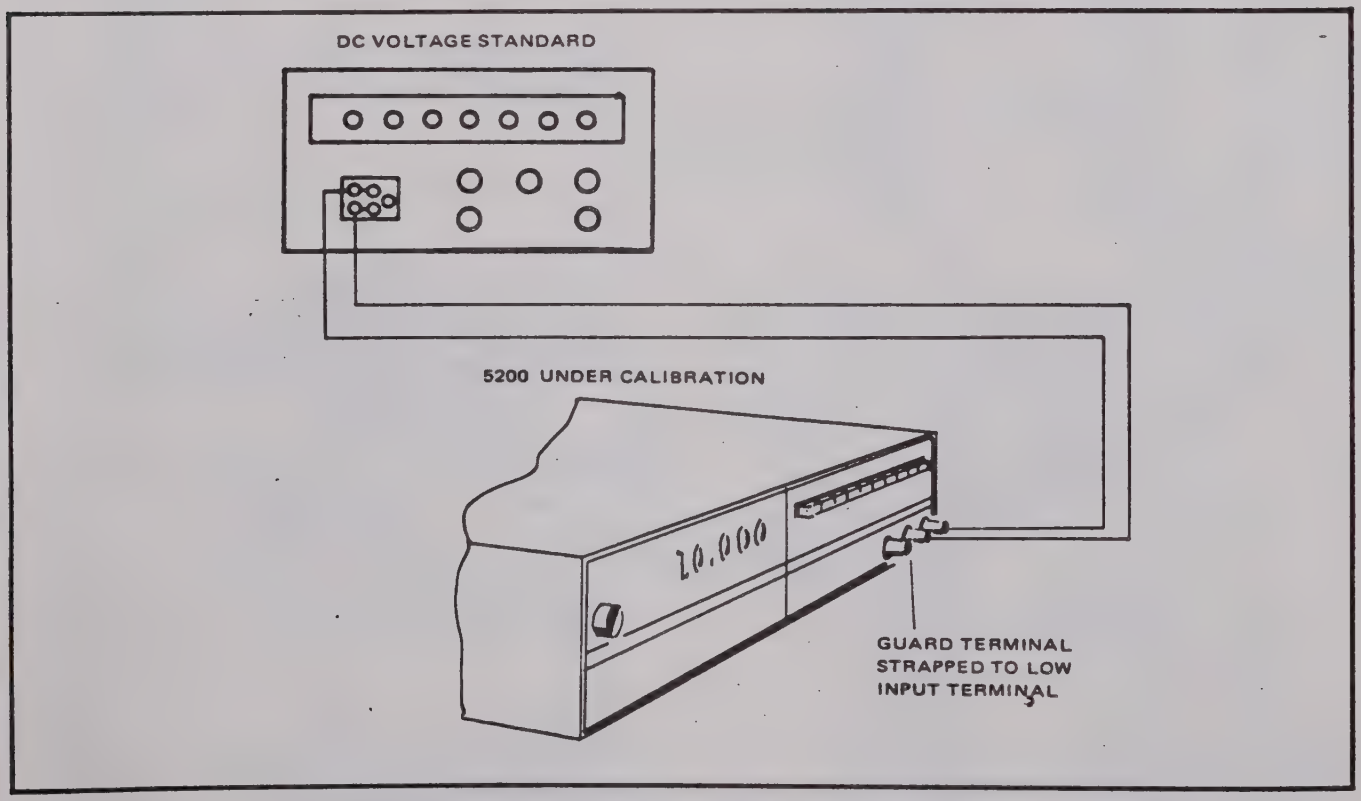


Figure 5.6 - Setup for 100V and 1000V DC range calibration

NOTE: If the instrument is not within the tolerance indicated in the above tests, the adjustments in sections 5.8 through 5.10 must be rechecked for error. If this does not correct the problem, the instrument is in need of repair.

(d) Disconnect the DMM from the voltage standard.

5.12 TEST OF THE "RATIO" MEASUREMENT ACCURACY REFER TO FIGURE 5.4. (NOTE: If the instrument is not equipped with the optional RATIO feature, disregard this section and proceed to Section 5.13).

(a) Connect the instrument to a stable source of approximately 10 volts as shown in figure 5.4. (10V ± 10%).

(b) Place the instrument in the "ratio" function by pressing the RATIO X10 pushbutton located on the rear panel.

(c) Place the instrument in the 10 volt DC range.

(d) Verify that the readout indicates 10.000 ± 33 digits.

(e) Adjust the voltage of the stable voltage source to approximately one volt. (1V ± 10%).

(f) Verify that the readout indicates 10.000 ± 60 digits.

NOTE: If the instrument is not within the tolerances indicated in the above tests, recheck the adjustments outlined in sections 5.8 through 5.11 for error. If this does not correct the problem the instrument is in need of repair.

(g) Switch the RATIO X10 pushbutton to "out" and disconnect the reference and signal input leads from the instrument.

5.13 DC VOLTAGE CALIBRATION OF THE SIGNAL CONDITIONING MODULE (Refer to Figure 5.5).

(a) Connect the test equipment and the instrument under calibration as shown in figure 5.5. Set all dials on the voltage standard and decade voltage divider to zero.

(b) Set the DMM controls as follows:

Function: DC Volts
Range: Auto
Ratio X10 Switch (rear panel): Out (If applicable)

(c) Verify that the DMM readout indicates all zeros and "bounces" between + and - polarity indicators. If necessary adjust the ZERO OFFSET potentiometer on the front of the instrument.

(d) Set the DC voltage standard to -10.0000 volts.

(e) Set the absolute ratio voltbox to X.1 (10:1).

(f) Set the decade voltage divider to .9999950.

(g) Slide the bottom cover of the instrument back just enough to expose the calibration potentiometers on the bottom of the signal conditioning module.

(h) Adjust potentiometer R-70 (the 1V DC range calibration potentiometer) so that the indication on the readout is "bouncing" between -.99999 and -1.00000.

(i) Connect the DMM input directly to the DC voltage standard as shown in figure 5.6. NOTE: Calibration of the 10 volt range was done in step 5.10.

(j) Adjust the output of the DC voltage standard to -99.9995.

(k) Adjust potentiometer R-13 (the 100 and 1000 volt adjustment potentiometer) so that the indication on the readout is "bouncing" between -99.999 and -100.000.

(l) Adjust the output of the DC voltage standard to zero volts.

(m) Slide the bottom cover of the instrument forward into place and set the instrument in an upright position. Allow five minutes for the operating temperature of the instrument to re-stabilize.

(n) Verify the accuracy of each range by following the tests in table 5.1.

Table 5.1

+1000.000	+1000.00 ± 2 digits[1]
+100.0000	+100.000 ± 2 digits[1]
+10.00000	+10.0000 ± 2 digits[2]
+1.000000	+1.00000 ± 2 digits[1]
- 1.000000	- 1.00000 ± 2 digits[1]
- 10.00000	- 10.0000 ± 2 digits[2]
- 100.0000	- 100.000 ± 2 digits[1]
- 1000.000	- 1000.00 ± 2 digits[1]

NOTES:

1) If the DMM readout is not within the specified accuracy, re-check the adjustments outlined in Section 5.13.

2) If the DMM readout is not within the specified accuracy, re-check the adjustments outlined in Section 5.10.

5.14 AC VOLTAGE CALIBRATION OF THE SIGNAL CONDITIONING MODULE (Refer to Figure 5.1a)

(NOTE: If the instrument is not equipped with the optional AC feature, disregard this section and proceed to section 5.16.)

(a) Set the DMM controls as follows:

Function: AC volts
Range: Auto
Range X10 Switch (on rear panel): Out (If applicable)

(b) Connect the DC voltage standard, thermal transfer voltmeter, AC laboratory source, and the DMM under calibration, as illustrated in Figure 5.7.

NOTE: There are eight distinct steps in the calibration of the AC Converter. They must be performed in sequence. All eight steps are shown in table 5.2. Sections 5.15-c through 5.15-h, which follow, give detailed instructions on how to perform step one. The remaining steps (2 through 8) are simply repeats of the same process at different voltages and frequencies and adjusting different controls. These differences are listed in table 5.2.

(c) Switch the thermal transfer voltmeter to DC input.

(d) Adjust the DC voltage standard for an output of +1.000000.

(e) Null the thermal transfer voltmeter. Allow sufficient time for the thermocouple in the voltmeter to stabilize.

(f) Switch the thermal transfer voltmeter to AC input and apply a 1 volt RMS, 400 Hz sine wave signal from the AC laboratory source. Adjust the amplitude controls on the AC source to produce the same null on

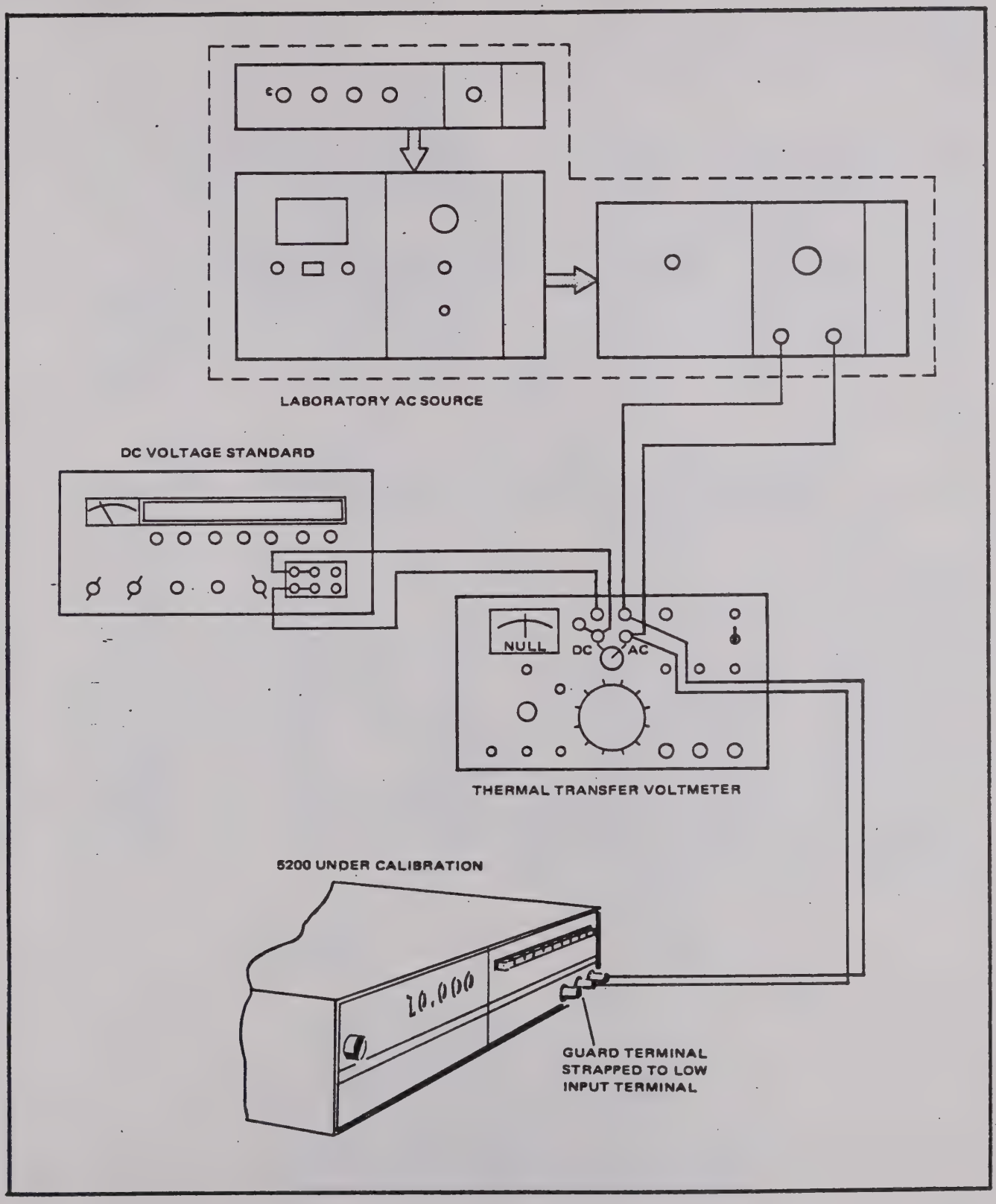


Figure 5.7 - Setup for AC calibration

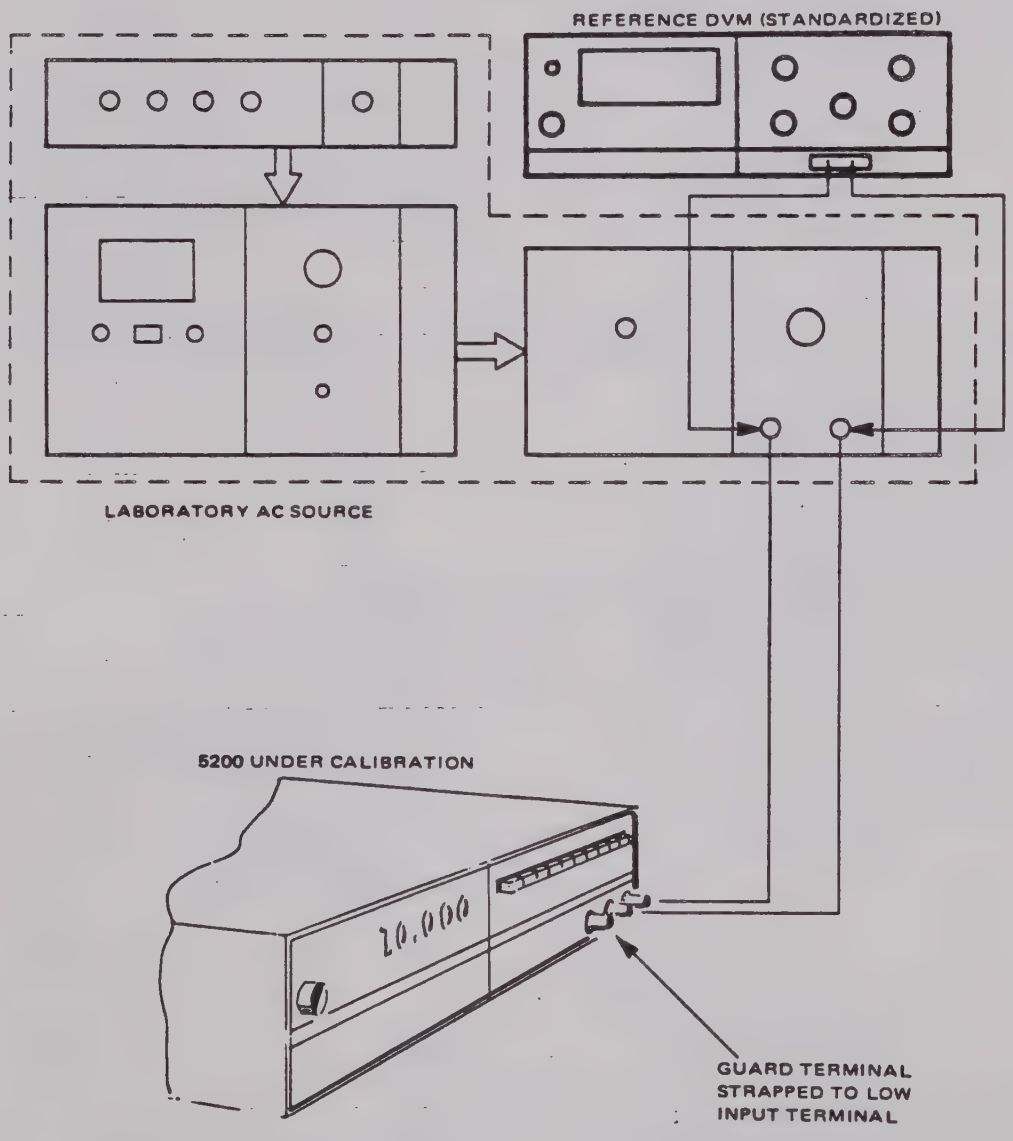


Figure 5.8 - Alternate setup for AC calibration

the thermal transfer voltmeter as with 1 volt DC.

(g) Slide the top cover of the instrument back far enough to expose the calibration controls on the top of the Signal Conditioning Module. (NOTE: If the instrument under calibration is a model 5270 it will be necessary to extend the Signal Conditioning Module forward, using extender kit no. (403017).

(h) Adjust the 1 volt low frequency potentiometer R-118 on the top of the Signal Conditioning Module to obtain a reading of -1.0000 ± 10 digit on the instruments readout.

(i) Repeat the same general procedure outlined in steps c through h above for each of the remaining calibration steps listed in table 5.2. Change the voltage and frequency, as indicated, for each range.

(j) The calibration of the AC converter is now complete. A check of the accuracy of the instrument at other frequencies and voltages than those listed in table 5.2. may be made by referring to table 5.3. This step is not necessary to the calibration of the AC converter, however certain user applications may require a more exact knowledge of the instruments accuracy at specific voltages and frequencies.

Table 5.2 - Sequence of adjustments required for AC converter calibration

Step	AC Input Voltage	Signal Frequency	Adjust	Readout Should Indicate	Remarks
1	1.00000V	400 Hz	R118	.99990 to 1.00010	1V Low Frequency
2	500.00V	400 Hz	R103	499.90 to 500.10	1000V Low Freq.
3	500.00V	10 kHz	C103	499.90 to 500.10	1000V High Freq.
4	1.00000V	10 kHz	C112	.99990 to 1.00010	1V High Freq.
5	10.0000V	400 Hz	R107	9.9990 to 10.0010	10V Low Freq.
6	10.0000V	10 kHz	C110	9.9990 to 10.0010	10V High Freq.
7	100.000V	400 Hz	R105	99.990 to 100.010	100V Low Freq.
8	100.000V	10 kHz	C108	99.990 to 100.010	100V High Freq.

(NOTE: Other techniques using an AC calibrator or a standardized digital voltmeter will perform this calibration procedure equally as well. Figure 5.8 illustrates the use of a Dana model 5700 DVM as the standardized digital voltmeter in such an application. This arrangement provides a direct reading capability.)

Table 5.3 - Allowable error in digits in AC volts function

If the Input Signal, on any given range, is:	The maximum number of digits error from 50 Hz to 100 Hz is:	The maximum number of digits error from 100 Hz to 5 kHz is:	The maximum number of digits error from 5 kHz to 20 kHz is:	The maximum number of digits error from 20 kHz to 100 kHz is:
0% of full scale (Input shorted)	± 100 digits	± 20 digits	± 50 digits	± 100 digits
10% of full scale	± 130 digits	± 30 digits	± 100 digits	± 300 digits
20% of full scale	± 150 digits	± 40 digits	± 150 digits	± 500 digits *
30% of full scale	± 180 digits	± 50 digits	± 200 digits	± 700 digits
40% of full scale	± 200 digits	± 60 digits	± 250 digits *	± 900 digits
50% of full scale	± 230 digits *	± 70 digits *	± 300 digits	± 1100 digits
60% of full scale	± 250 digits	± 80 digits	± 350 digits	± 1300 digits
70% of full scale	± 280 digits	± 90 digits	± 400 digits	± 1500 digits
80% of full scale	± 300 digits	± 100 digits	± 450 digits	± 1700 digits
90% of full scale	± 330 digits	± 110 digits	± 500 digits	± 1900 digits
100% of full scale	± 350 digits	± 120 digits	± 550 digits	± 2100 digits
110% of full scale	± 380 digits	± 130 digits	± 600 digits	± 2300 digits
120% of full scale	± 400 digits	± 140 digits	± 650 digits	± 2500 digits

*Refer to Table 5.4. Maximum input on 1000V AC range is 500V RMS (50 Hz to 10 kHz) decreasing to 100V RMS at 100 kHz.

Table 5.4 - Maximum AC Input on 1000 VAC Range

Maximum percentage of full scale AC RMS input on the 1000 V AC range is 500 V RMS from 50 Hz to 10 kHz decreasing to 100 V RMS at 100 kHz.

Frequency	Maximum AC Input Voltage
50 Hz to 10 kHz	500 V RMS
20 kHz	455 V RMS
30 kHz	415 V RMS
40 kHz	370 V RMS
50 kHz	325 V RMS
60 kHz	275 V RMS
70 kHz	230 V RMS
80 kHz	190 V RMS
90 kHz	145 V RMS
100 kHz	100 V RMS

5.15 OHMS CALIBRATION OF THE SIGNAL CONDITIONING MODULE (Refer to Figure 5.1a).

(NOTE: If the instrument is not equipped with the optional OHMS feature, the calibration is now concluded).

(a) Clip the input leads on the end of the instrument's input cable together.

(b) Set the DMM controls as follows:

Function: DC
Range: Auto
Ratio X10 Switch (on rear panel): Out (If applicable)

(c) The instrument should auto-range to the lowest range and read .00000.

(d) Adjust the ZERO OFFSET potentiometer on the front of the instrument so that the polarity indicators are "bouncing" between + and -.

(e) Select the OHMS function. The instrument should now indicate 0.0000 plus the resistance of the input cable. This resistance may give an offset of one or two digits from zero. Carefully note the exact amount of this offset (if any).

(f) Connect the test leads to the 1000 ohm standard resistor.

(g) Adjust the 1 Kilohm Range Calibration Control (R154) so that the instrument indicates the exact value of the standard resistor plus the number of digits offset noted in step (c) above (the resistance of the input cable).

(h) Connect the test leads to the 10 Megohm standard resistor.

(i) Adjust the 10,000 Kilohm Range Calibration Control (R134) so that the instrument indicates the exact value of the standard resistor.

(j) Adjust the 10 Kilohm Range Calibration control (R115) so that the instrument indicates the exact value of the standard resistor.

(k) Connect the test leads to the 100 Kilohm standard resistor.

(l) Adjust the 100 Kilohm Calibration Control (R123) so that the instrument indicates the exact value of the standard resistor.

(m) Connect the test leads to the 1 Megohm standard resistor.

(n) Adjust the 1000 Kilohm Calibration Control (R130) so that the instrument indicates the exact value of the standard resistor.

(o) Re-check steps (e) through (n) above and repeat any adjustments necessary until the instrument indicates correctly on each range without further adjustments.

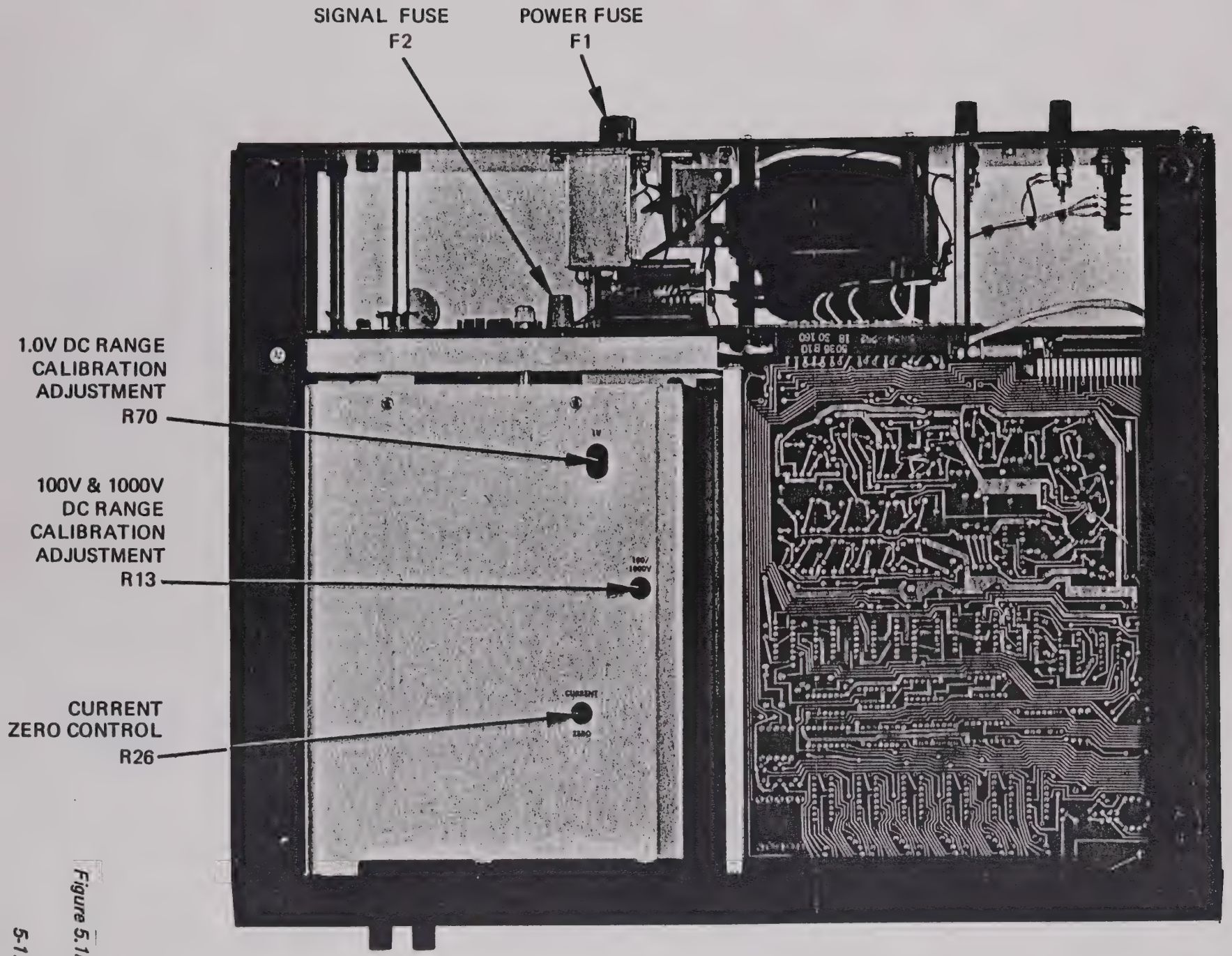

SIGNAL FUSE
F2
POWER FUSE
F1
1.0V DC RANGE
CALIBRATION
ADJUSTMENT
R70
100V & 1000V
DC RANGE
CALIBRATION
ADJUSTMENT
R13
CURRENT
ZERO CONTROL
R26

Figure 5.1b

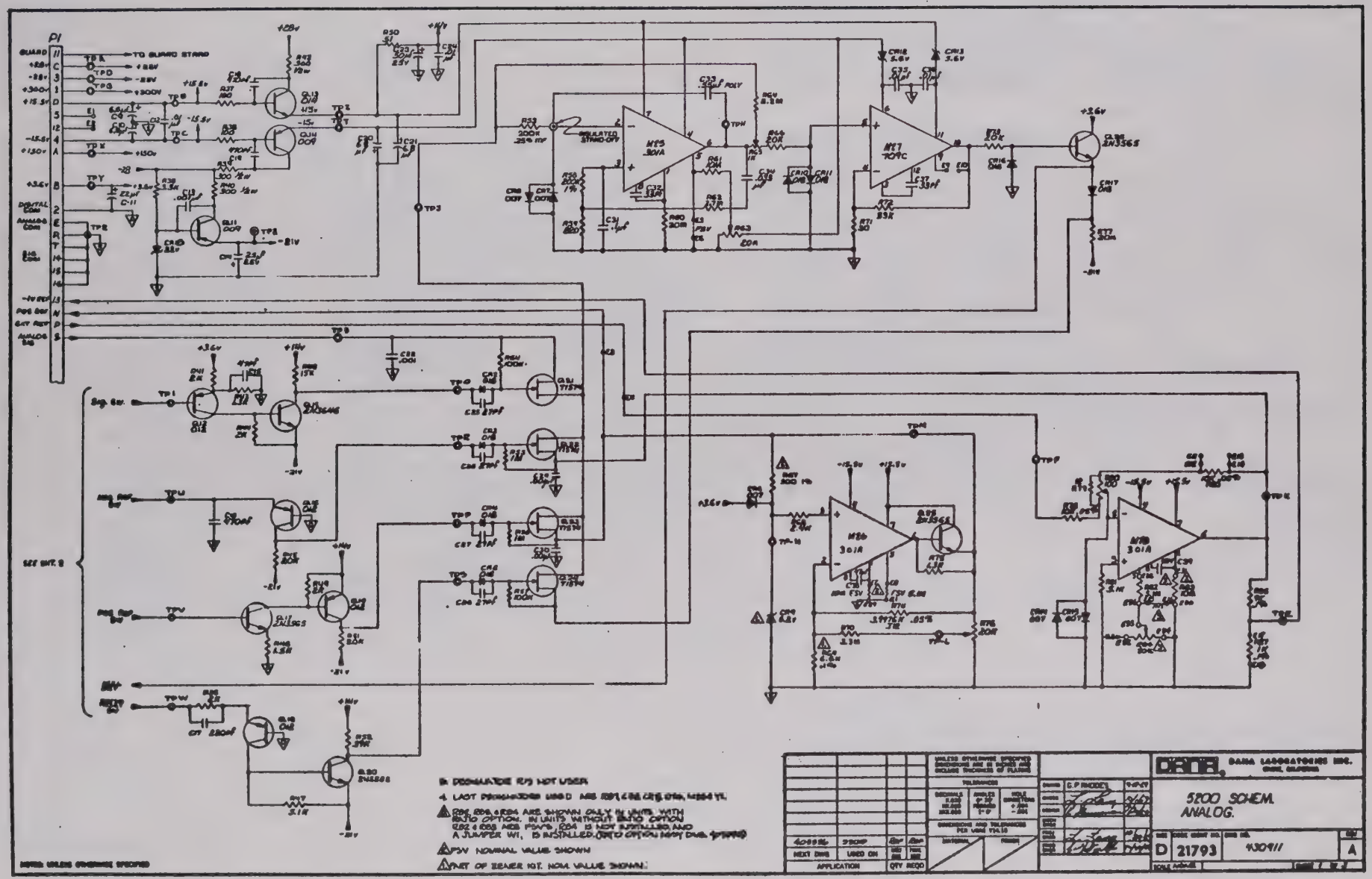
SECTION 6

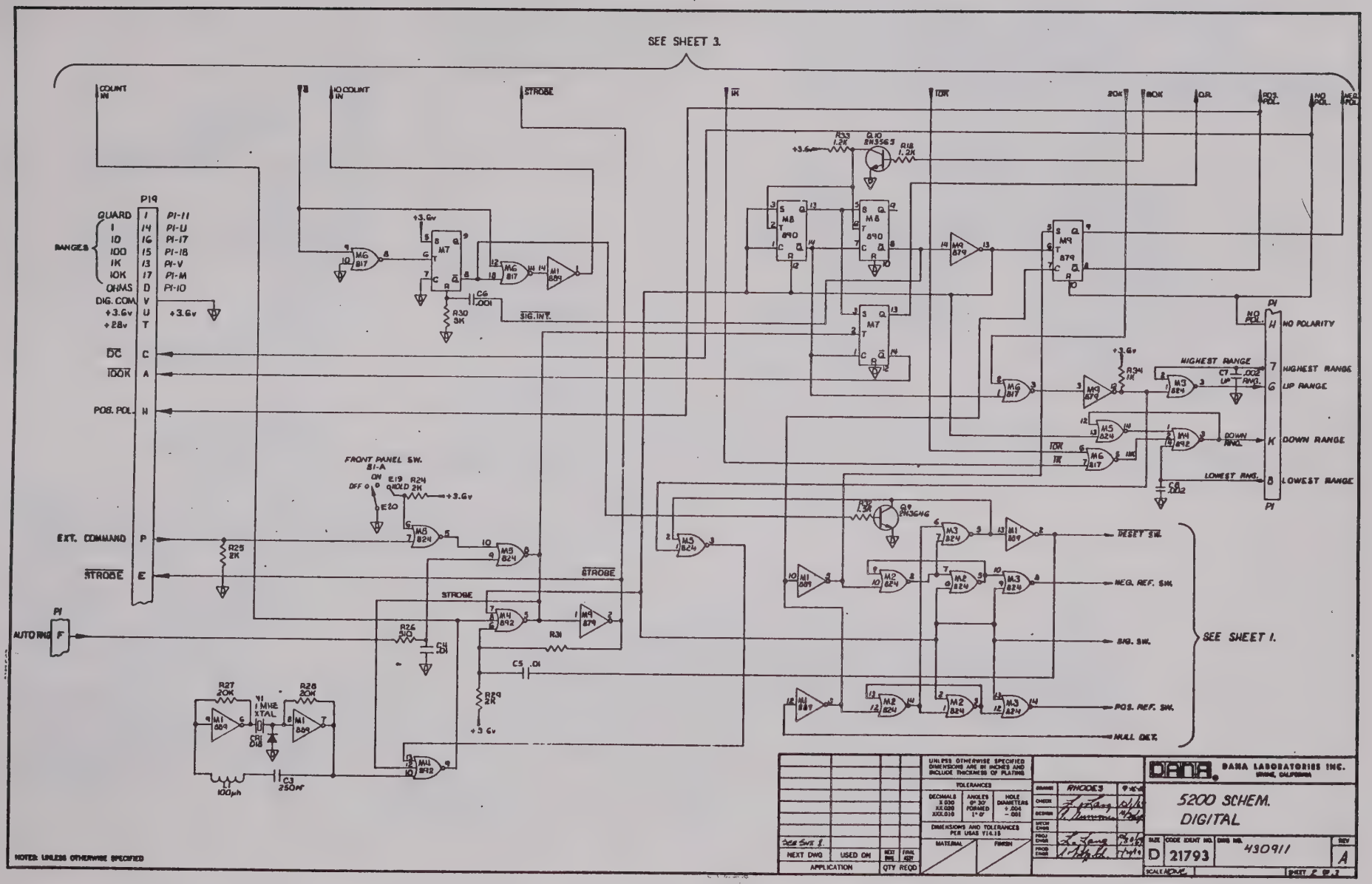
DRAWINGS

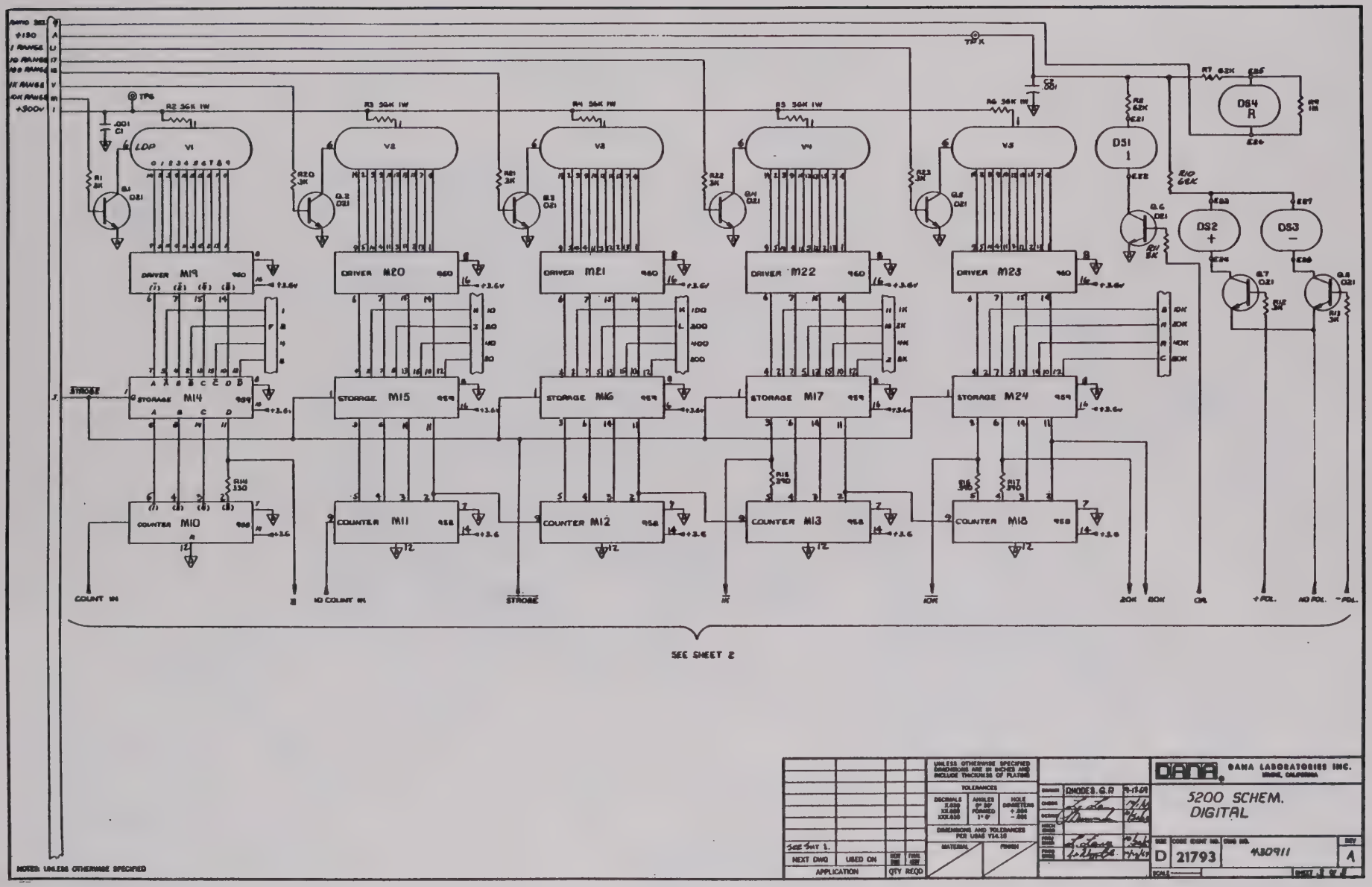
6.1 DRAWINGS	Drawing No.
Readout Assembly	403446
Readout Schematic Digital	430960-3
	430960-2
Readout Schematic Analog	430960-1
Isolator Assembly Model 550	403304-1
Isolator Schematic Digital	430903-1
Isolator Schematic Analog	430903-2
AC Accessory Model 550-01	403203-1
AC Accessory Assembly	403214-2
AC Accessory Assembly Schematic	430870-1
Ohms Accessory Model 550-02	403228-1
Ohms Accessory Assembly	403169-1
Ohms Accessory Schematic	430871-1
AC/Ohms Accessory Model 550-03	403229-1
AC/Ohms Accessory Assembly	402581-2
AC/Ohms Accessory Schematic	430868-1
Ratio Option Model 04 Full Rack	403333-2
Ratio Option Model 04 Half Rack	403333-1
Ratio Option Assembly Readout	403333-3
BCD Output Option - 05 Assembly	403323-1
BCD Output Option - 05 Schematic	430912-1
Analog Signal Output Option - 06 Assembly Full Rack	403262-1
Analog Signal Output Option - 06 Assembly Half Rack	403262-2
Rear Input Assembly Option 550-1	403325-1
Rear Input Assembly - 5230-5270	403230-1
DMM Full Rack Assembly 5230	400962
Power Supply Assembly Full Rack	403208-1
Power Supply Assembly Full Rack PCB	403081-2
Power Supply Schematic	430842-1
Power Supply Assembly 220/240V Full Rack	403269-1

DRAWINGS (Continued)

DRAWINGS	Drawing No.
DMM Half Rack Assembly 5270	400963
Power Supply Assembly Half Rack	403233-1
Power Supply Assembly Half Rack PCB	403225-2
Power Supply Schematic	430842-1
Power Supply Assembly 220/240V Half Rack	403269-2
DMM Full Rack 5233	409009/23/24
Isolated Output 5233/07	409000
Isolated Output Schematic	439000
Program Board, 553 Module	409001
Program Board, Schematic	439001


P1
TO GUARD STAND
SEE SHT. 2
5200 SCHEM. ANALOG.
DANA LABORATORIES INC.
IRVINE, CALIFORNIA
D
21793
430911
A


SEE SHEET 3.
COUNT IN
10 COUNT IN
STROBE
IN
10R
20K
80K
DP.
800 MODE
NO MODE
NEG MODE
P19
RANGES
GUARD
1
10
100
1K
10K
OHMS
DIG. COM
+3.6v
+28v
DC
100R
POS. POL
EXT. COMMAND
STROBE
AUTO RNG
P1
NO POLARITY
HIGHEST RANGE
UP RANGE
DOWN RANGE
LOWEST RANGE
FRONT PANEL SW. S1-A
SIG. INT.
RESET SW.
NEG. REF. SW.
SIG. SW.
POS. REF. SW.
NULL DET.
SEE SHEET 1.
1 MHz XTAL
100μh
250pf
NOTES: UNLESS OTHERWISE SPECIFIED
DANA LABORATORIES INC.
IRVINE, CALIFORNIA
5200 SCHEM. DIGITAL
SIZE D
CODE IDENT NO. 21793
DWG NO. 430911
REV A
SCALE NONE
SHEET 2 OF 3



NOTES: UNLESS OTHERWISE SPECIFIED

SEE SHT 1		
NEXT DWG	USED ON	QTY REQD
APPLICATION		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES

DECIMALS	ANGLES	HOLE DIAMETERS
X.XXX ± .010 XX.XXX ± .005 XXX.XXX ± .002	± 30' FRACTIONS 1° 0'	+ .004 − .004

DIMENSIONS AND TOLERANCES PER USAS Y14.5

MATERIAL | FINISH

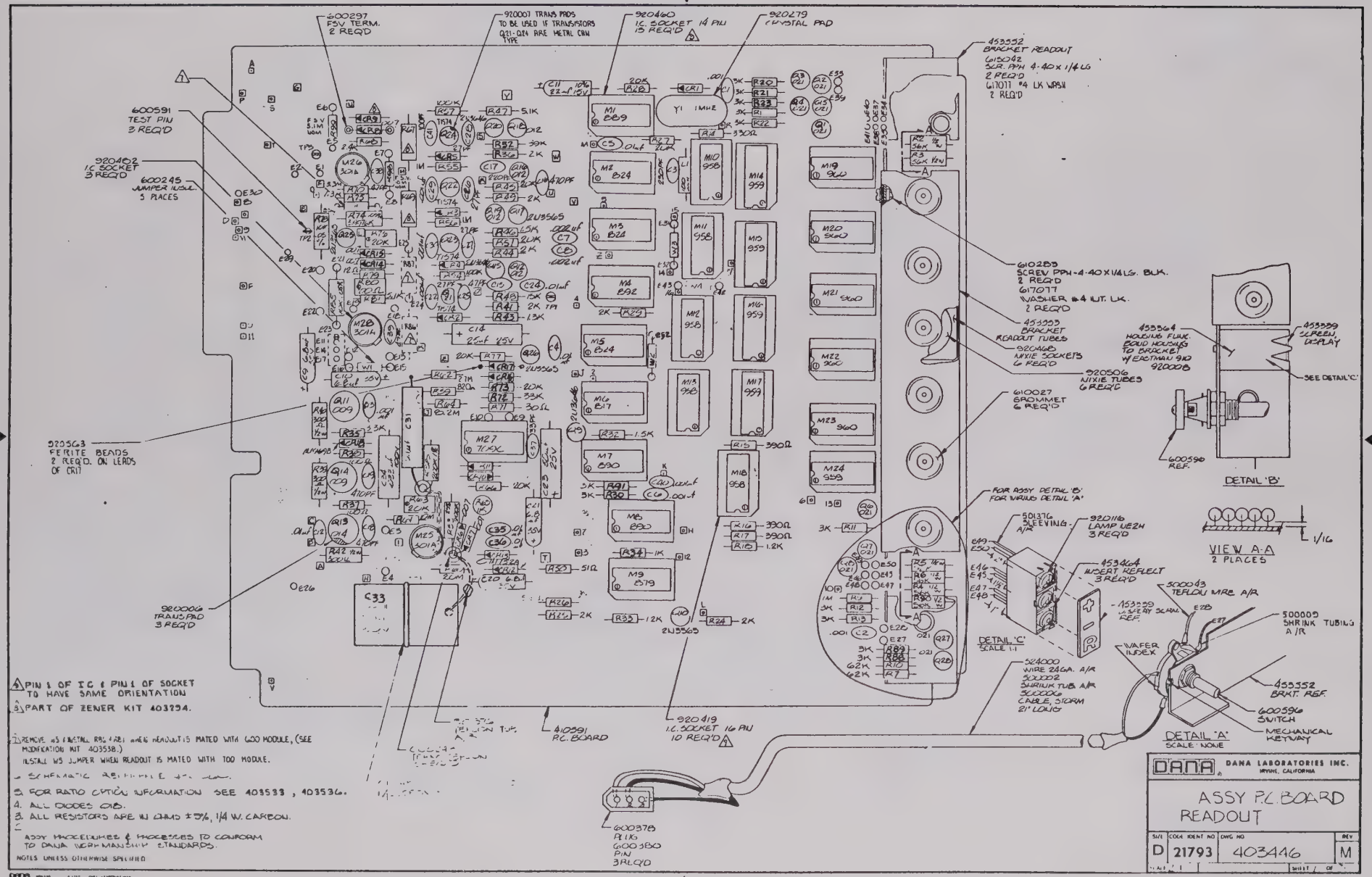
DRAWN	DIODES, G.R.	9-13-61
CHECK		
ENGR		
MFG		
FINAL INSP		
FINAL QUAL		

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

5200 SCHEM. DIGITAL

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	430911	A

SCALE — SHEET 1 OF 2


600297 FSV TERM. 2 REQ'D
920007 TRANS PADS TO BE USED IF TRANSISTORS Q21-Q24 ARE METAL CAN TYPE
920460 I.C. SOCKET 14 PIN 15 REQ'D
920279 CRYSTAL PAD
453552 BRACKET READOUT
600591 TEST PIN 3 REQ'D
920462 I.C. SOCKET 3 REQ'D
600245 JUMPER WIRE 5 PLACES
610283 SCREW PPH-4-40 X 1/4 LG. BLK. 2 REQ'D
617077 WASHER #4 INT. LK. 2 REQ'D
453553 BRACKET READOUT TUBES
920468 NIXIE SOCKETS 6 REQ'D
920506 NIXIE TUBES 6 REQ'D
453364 HOUSING FUNK BOLD HOUSING TO BRACKET W/ERTMAN 940 920008
453339 SCREEN, DISPLAY
SEE DETAIL 'C'
610027 GROMMET 6 REQ'D
600590 REF.
DETAIL 'B'
920563 FERITE BEADS 2 REQ'D. ON LEADS OF CR17
FOR ASSY DETAIL 'B' FOR WIRING DETAIL 'A'
501376 SLEEVING A/R
920116 LAMP NE2H 3 REQ'D
453404 INSERT REFLECT 3 REQ'D
VIEW A-A 2 PLACES
1/16
500043 TEFLON WIRE A/R
153239 LAMP SCRN REF.
500005 SHRINK TUBING A/R
WAFER INDEX
453352 BRKT. REF.
600596 SWITCH
MECHANICAL KEYWAY
DETAIL 'A' SCALE: NONE
DETAIL 'C' SCALE 1:1
524000 WIRE 24GA. A/R
500002 SHRINK TUB A/R
500004 CABLE, RIBBON 21 LONG
920006 TRANS PAD 3 REQ'D
410591 P.C. BOARD
920419 I.C. SOCKET 16 PIN 10 REQ'D
600378 PLUG 600380 PIN 3 REQ'D
2N3565
C33

4. PIN 1 OF IC & PIN 1 OF SOCKET TO HAVE SAME ORIENTATION
3. PART OF ZENER KIT 403294.

2. REMOVE W5 & INSTALL R86 (4.2K) WHEN READOUT IS MATED WITH 600 MODULE, (SEE MODIFICATION KIT 403538.)
INSTALL W5 JUMPER WHEN READOUT IS MATED WITH 700 MODULE.

1. SCHEMATIC REFERENCE DWG. 403533.
5. FOR RATIO OPTION INFORMATION SEE 403533, 403536.
4. ALL DIODES 018.
3. ALL RESISTORS ARE IN OHMS ±5%, 1/4 W. CARBON.
2. ASSY PROCEDURES & PROCESSES TO CONFORM TO DANA WORKMANSHIP STANDARDS.

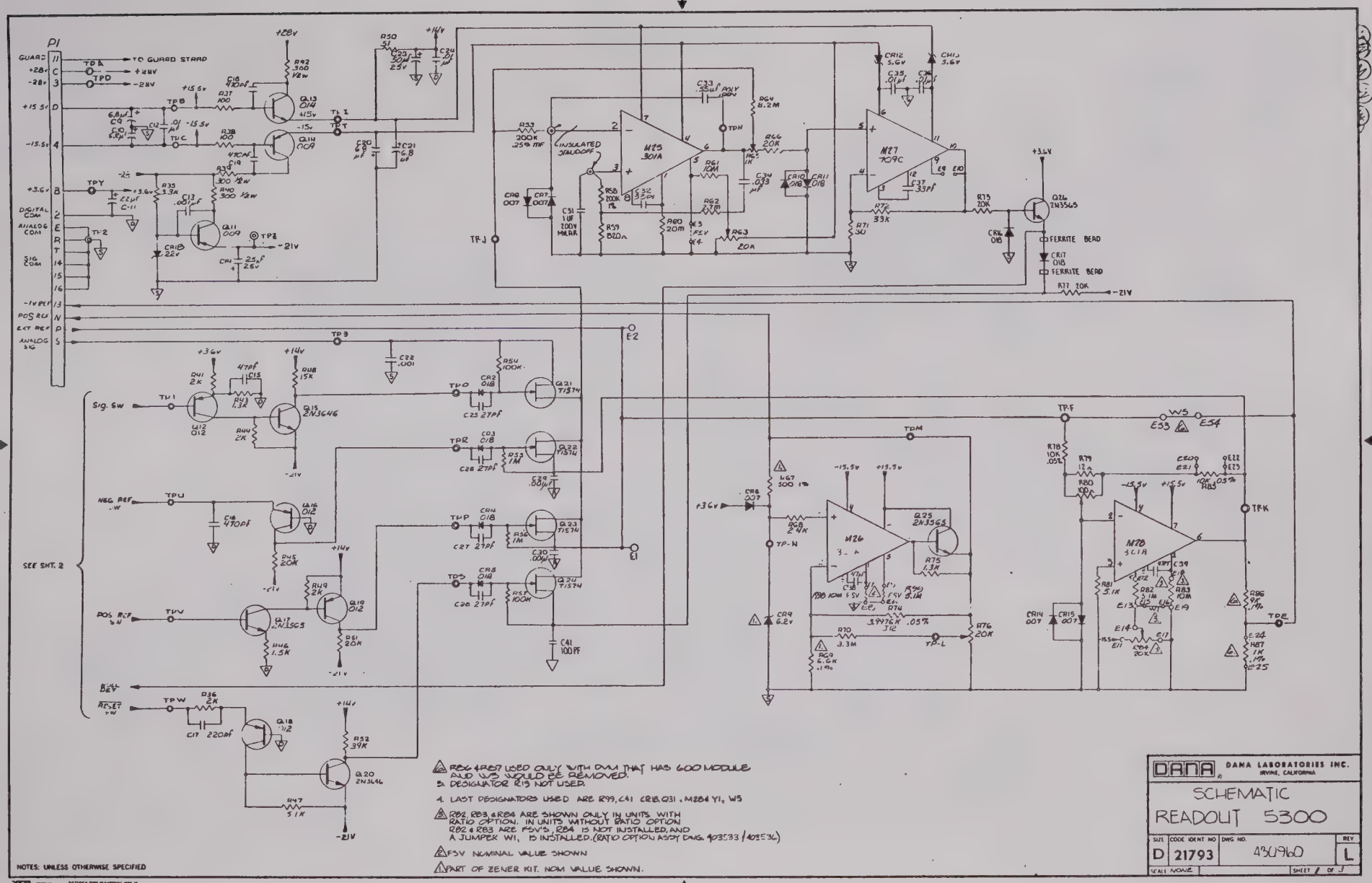
NOTES UNLESS OTHERWISE SPECIFIED

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSY P.C. BOARD READOUT

SIZE	CODE IDENT NO	DWG NO	REV
D	21793	403446	M

SHEET / OF



⚠4 R96 & R97 USED ONLY WITH DVM THAT HAS 600 MODULE AND W3 WOULD BE REMOVED.
5. DESIGNATOR R13 NOT USED.
4. LAST DESIGNATORS USED ARE R99, C41, CR18, Q31, M28 & Y1, W5
⚠2 R82, R83, & R84 ARE SHOWN ONLY IN UNITS WITH RATIO OPTION. IN UNITS WITHOUT RATIO OPTION R82 & R83 ARE FSV'S, R84 IS NOT INSTALLED, AND A JUMPER W1, IS INSTALLED. (RATIO OPTION ASSY DWG. 403533/403536)
⚠2 FSV NOMINAL VALUE SHOWN
⚠1 PART OF ZENER KIT. NOM VALUE SHOWN.

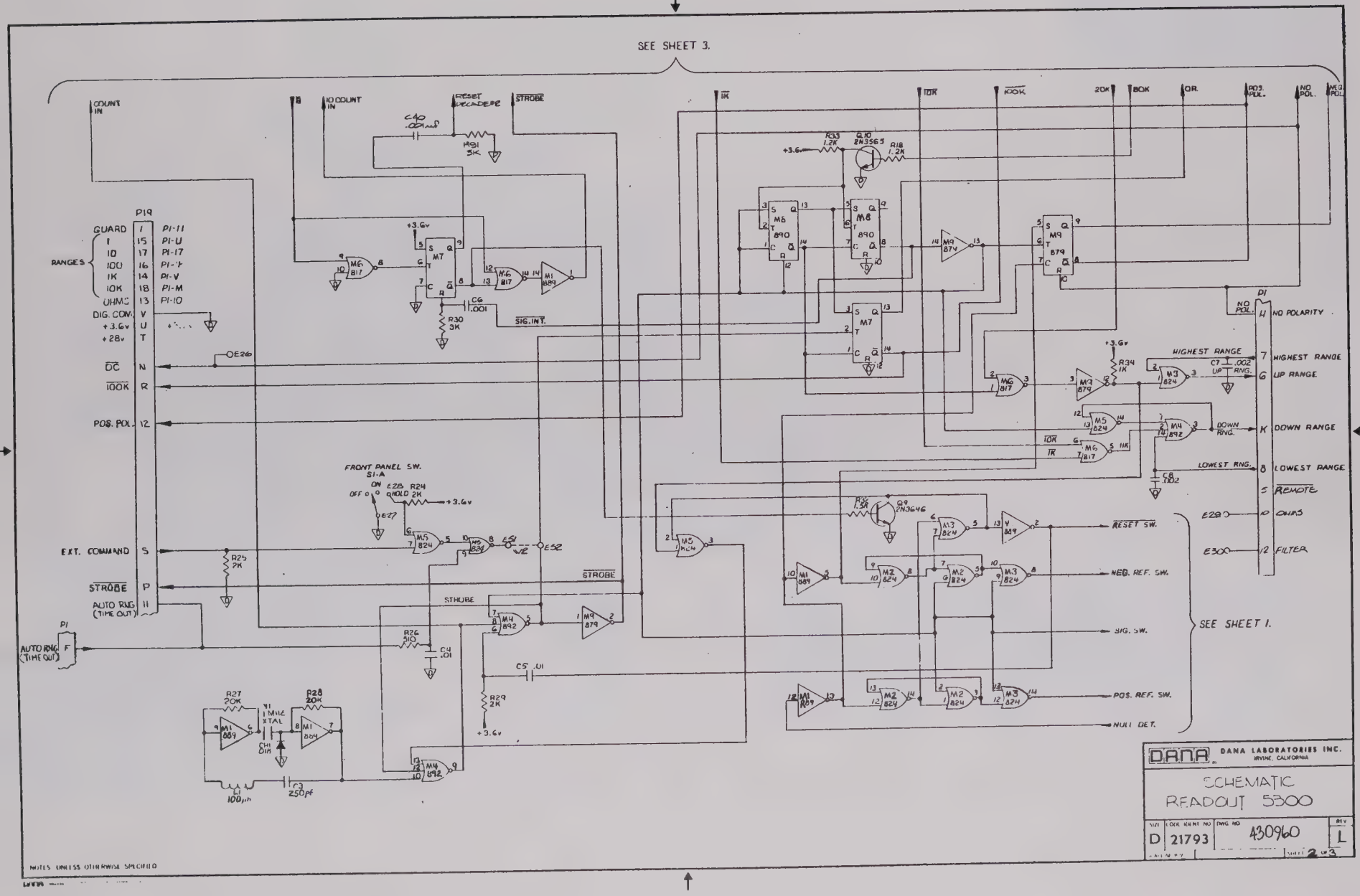
NOTES: UNLESS OTHERWISE SPECIFIED

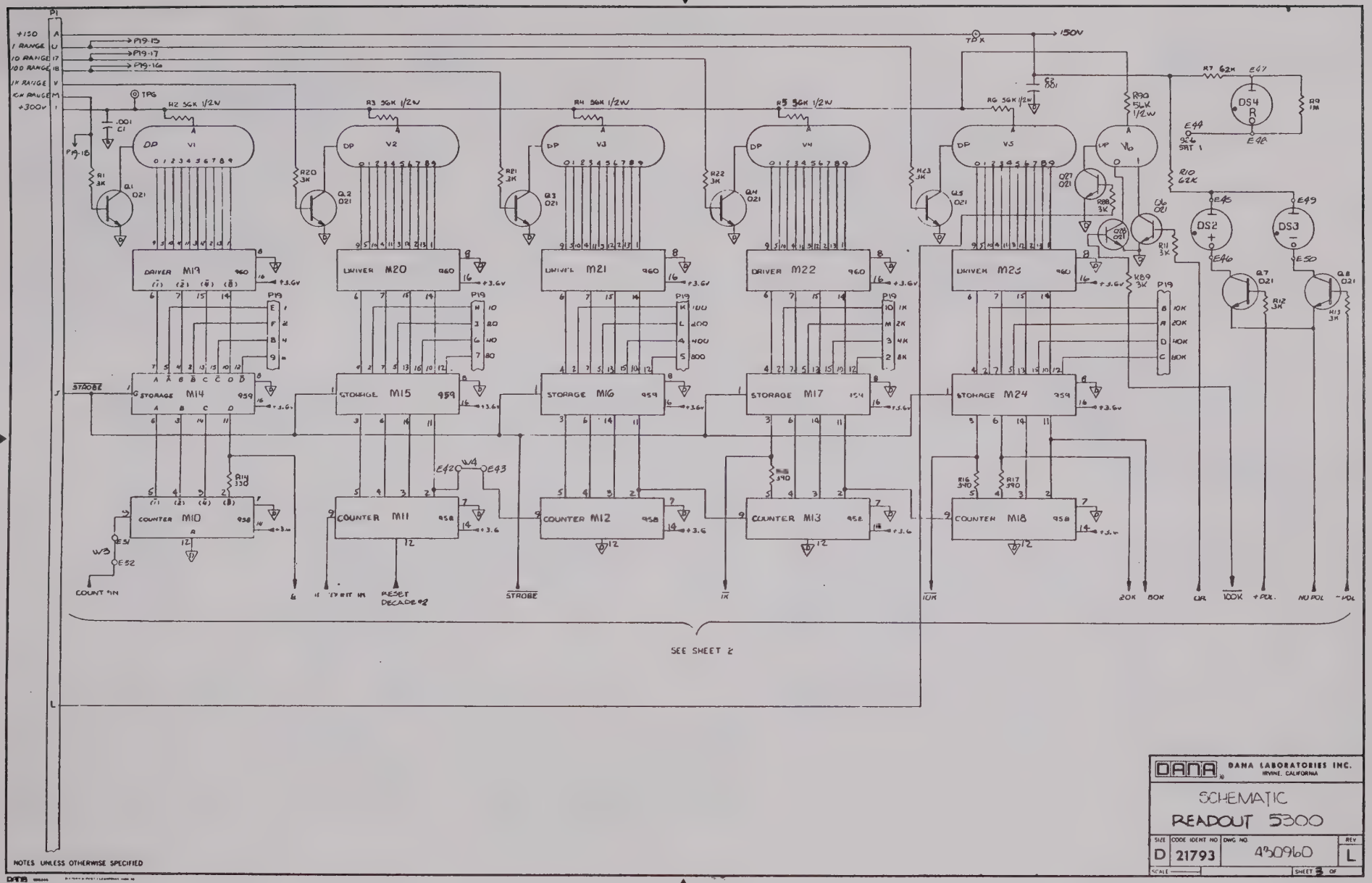
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC
READOUT 5300

SIZE	CODE IDENT NO	DWG NO.	REV
D	21793	430960	L

SCALE NONE SHEET 1 OF 3


SEE SHEET 3.
COUNT IN
10 COUNT IN
RESET DECADES
STROBE
1R
10R
100R
20K
80K
OR.
POS. POL.
NO POL.
NEG. POL.
P19
GUARD
RANGES
DIG. COM.
+3.6v
+28v
DC
100R
POS. POL.
EXT. COMMAND
STROBE
AUTO RNG (TIME OUT)
P1
SIG. INT.
FRONT PANEL SW. S1-A
ON
OFF
HOLD
+3.6v
RESET SW.
NEG. REF. SW.
SIG. SW.
POS. REF. SW.
NULL DET.
SEE SHEET 1.
HIGHEST RANGE
UP RANGE
DOWN RANGE
LOWEST RANGE
REMOTE
OVRS
FILTER
NO POLARITY
DANA LABORATORIES INC.
IRVINE, CALIFORNIA
SCHEMATIC
READOUT 5300
D
21793
430960
L
NOTES UNLESS OTHERWISE SPECIFIED



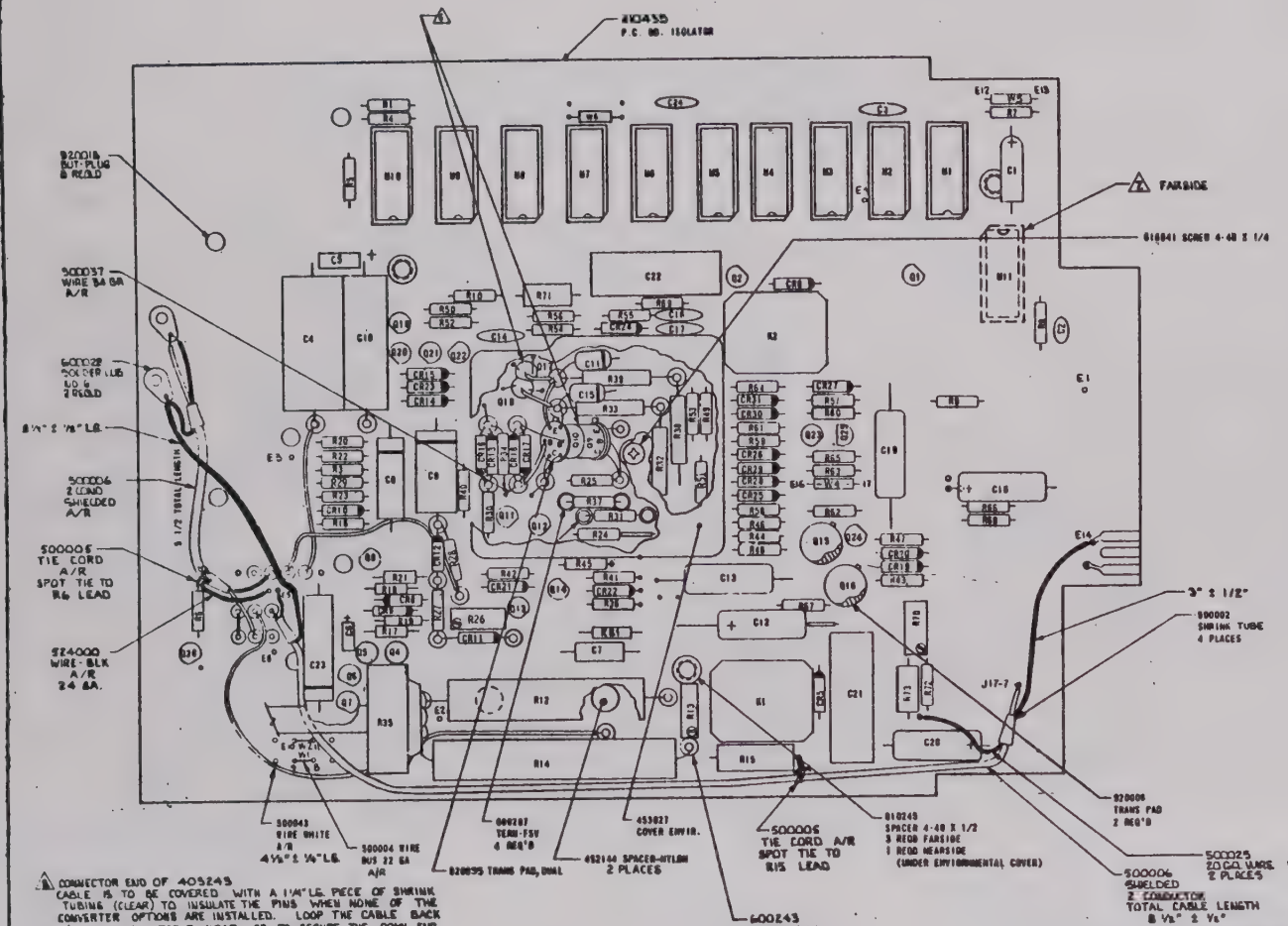
NOTES UNLESS OTHERWISE SPECIFIED

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC
READOUT 5300

SIZE	CODE IDENT NO	DWG NO	REV
D	21793	430960	L

SCALE — SHEET 3 OF



REVISIONS				
LTR	DESCRIPTION	DR	CHK	APP'D
A	RELEASED PER DRN 923			
B	ADD R81, CHANGE VALUES OF C7, R21 & R22 PER EO 5277			
C	MOUNT ONE END OF R34 TO PCB EO 5327			
D	600339 WAS 600527 PER EO 5345			
E	Q415 ARE 213565 PER EO 5393			
F	REVISED PER EO. 5494			
H	REVISED PER EO. 5507			
J	R70 WAS 040026, ADD NOTE TO 600496 ON SHT 2 PER EO 5549			
K	ADD DETAIL TO CLARIFY Q9-13 GLUING INSTRUCTIONS EO 5571			
L	920460 WAS 902460 EO. 5755			
M	CORRECT VALUE OF R22 PER EO 5759			

⚠1 CONNECTOR END OF 403243 CABLE IS TO BE COVERED WITH A 1¼" LG. PIECE OF SHRINK TUBING (CLEAR) TO INSULATE THE PINS WHEN NONE OF THE CONVERTER OPTIONS ARE INSTALLED. LOOP THE CABLE BACK & TIE IT TO ITSELF NEAR S3 TO SECURE THE CONN. END.

⚠2 MII SOCKET AND COMPONENT MOUNTED ON FARSIDE.

⚠3 TO BE CEMENTED TOGETHER WITH EASTMAN #910. (PRU 920004)

5 RELAYS K1-K7. RESISTOR R35 AND ALL PUSH BUTTON SWITCHES ARE TO BE FREE OF CONTAMINANTS.

4 SCHEMATIC REFERENCE 430903.

3 ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM WITH DANA WORKMANSHIP STANDARDS.

2 ALL DIODES TO BE 1N8.

1 ALL RESISTORS ARE IN OHMS 1/4W. ±5% CARBON.

NOTES: UNLESS OTHERWISE SPECIFIED

403293	550	1	1
NEXT DWG	USED ON	REQ'D PER ASSY	TOTAL QTY REQD
APPLICATION			

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS | ANGLES | HOLE DIAMETERS
X .030 | 0 30' | FORMED .004
XX .020 | FORMED | .001
XXX .010 | 1 0' |
MATERIAL
FINISH

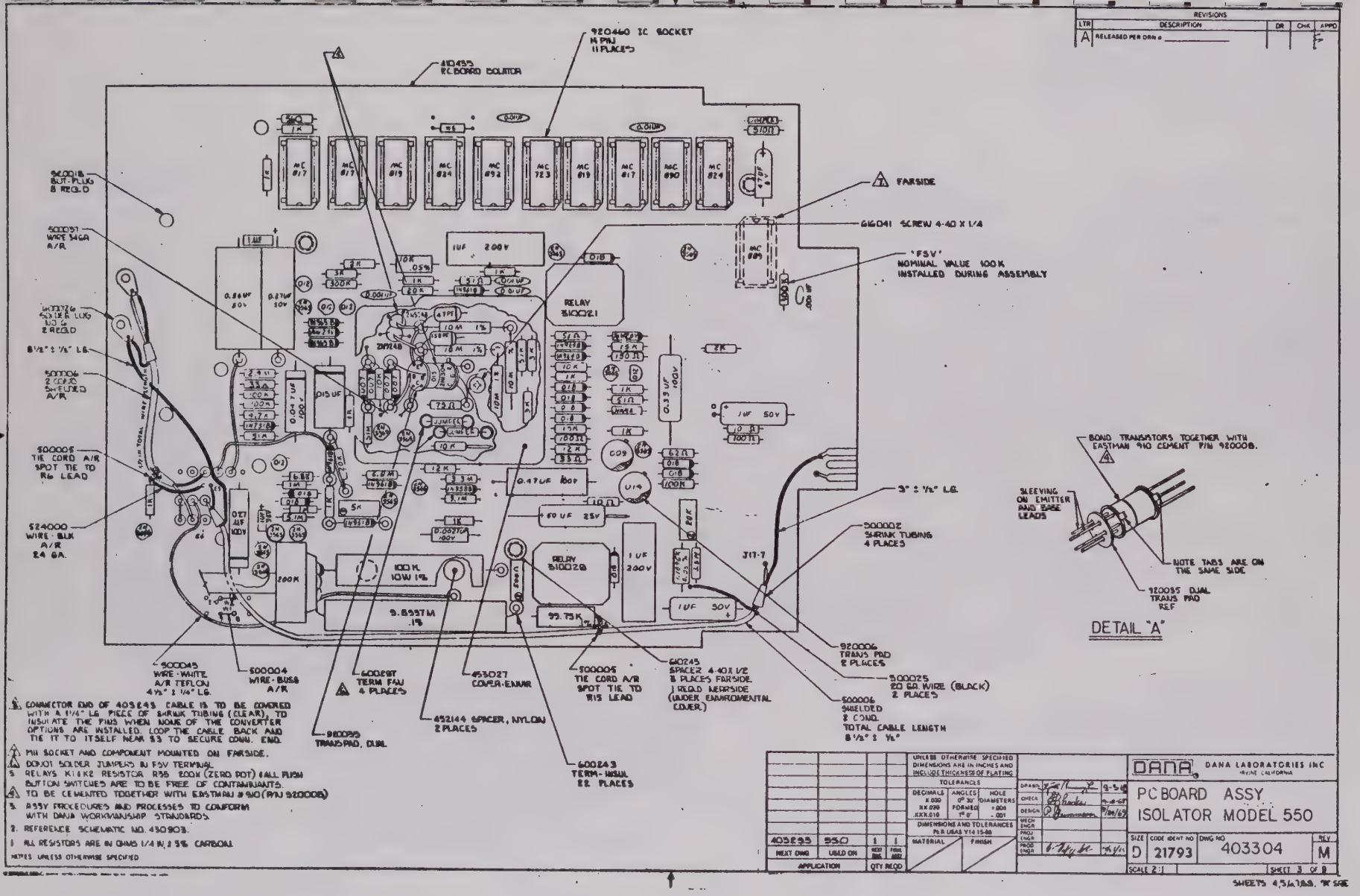
DANA LABORATORIES INC.
IRVINE CALIFORNIA

P.C. BD. ASSY
ISOLATOR MODEL 550

SIZE	CODE IDENT NO	DWG NO	REV
D	21793	403304	M

SCALE 2:1 SHEET 1 OF 2

SHEETS 2 THRU 5 SAME


REVISIONS
LTR DESCRIPTION DR CHK APPD
A RELEASED PER ORN #
410452 PC BOARD ISOLATOR
920460 IC SOCKET 14 PIN 11 PLACES
FARSIDE
616041 SCREW 4-40 X 1/4
'FSV' NOMINAL VALUE 100K INSTALLED DURING ASSEMBLY
RELAY 310021
RELAY 310020
9.8997M 1%
99.73K 1%
100K 10W 1%
200K
BOND TRANSISTORS TOGETHER WITH EASTMAN 910 CEMENT P/N 920008.
SLEEVING ON EMITTER AND BASE LEADS
NOTE TABS ARE ON THE SAME SIDE
920095 DUAL TRANS PAD REF
DETAIL "A"
3" ± 1/2" LG.
500002 SHRINK TUBING 4 PLACES
J11-7
920006 TRANS PAD 2 PLACES
500025 20 GA WIRE (BLACK) 2 PLACES
500006 SHIELDED 2 COND. TOTAL CABLE LENGTH 8 1/2" ± 1/2"
600245 SPACER 4-40 X 1/2 8 PLACES FARSIDE. 1 REQ'D NEARSIDE (UNDER ENVIRONMENTAL COVER)
500005 TIE CORD A/R SPOT TIE TO R15 LEAD
600243 TERM-INSUL 22 PLACES
452144 SPACER, NYLON 2 PLACES
453027 COVER-ENVIR
600287 TERM PAN 4 PLACES
920095 TRANS PAD, DUAL
500004 WIRE-BUSS A/R
500045 WIRE-WHITE A/R TEFLON 4 1/2" ± 1/4" LG.
924000 WIRE-BLK A/R 24 GA.
500005 TIE CORD A/R SPOT TIE TO R6 LEAD
500004 2 COND SHIELDED A/R
8 1/2" ± 1/2" LG.
603276 SOLDER LUG NO 6 2 REQ'D
500037 WIRE 24GA A/R
920018 BUT-PLUG 8 REQ'D

1. CONNECTOR END OF 403243 CABLE IS TO BE COVERED WITH A 1 1/4" LG PIECE OF SHRINK TUBING (CLEAR), TO INSULATE THE PINS WHEN NONE OF THE CONVERTER OPTIONS ARE INSTALLED. LOOP THE CABLE BACK AND TIE IT TO ITSELF NEAR J3 TO SECURE CONN. END.
2. MIN SOCKET AND COMPONENT MOUNTED ON FARSIDE.
3. DO NOT SOLDER JUMPERS IN FSV TERMINAL.
4. RELAYS K1 & K2 RESISTOR R35 200K (ZERO POT) & ALL PUSH BUTTON SWITCHES ARE TO BE FREE OF CONTAMINANTS.
5. TO BE CEMENTED TOGETHER WITH EASTMAN # 910 (P/N 920008)
6. ASSY PROCEDURES AND PROCESSES TO CONFORM WITH DANA WORKMANSHIP STANDARDS.
7. REFERENCE SCHEMATIC NO. 450903.
8. ALL RESISTORS ARE IN OHMS 1/4 W, 2 5% CARBON.

NOTES UNLESS OTHERWISE SPECIFIED

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING
TOLERANCES
DECIMALS X.000 ± .010, XX.030 ± .010, XXX.010 ± .005
ANGLES 0° 30' FORMED 1° 0'
HOLE DIAMETERS +.004 -.001
DIMENSIONS AND TOLERANCES PER USAS Y14.15-66
MATERIAL FINISH

403E35	550	1	1
NEXT DWG	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QTY REQD	

DRAWN 9-5-68
CHECK 9-26-68
DESIGN 10/11/68
MECH ENGR
PROJ ENGR
PROD ENGR 6-24-69

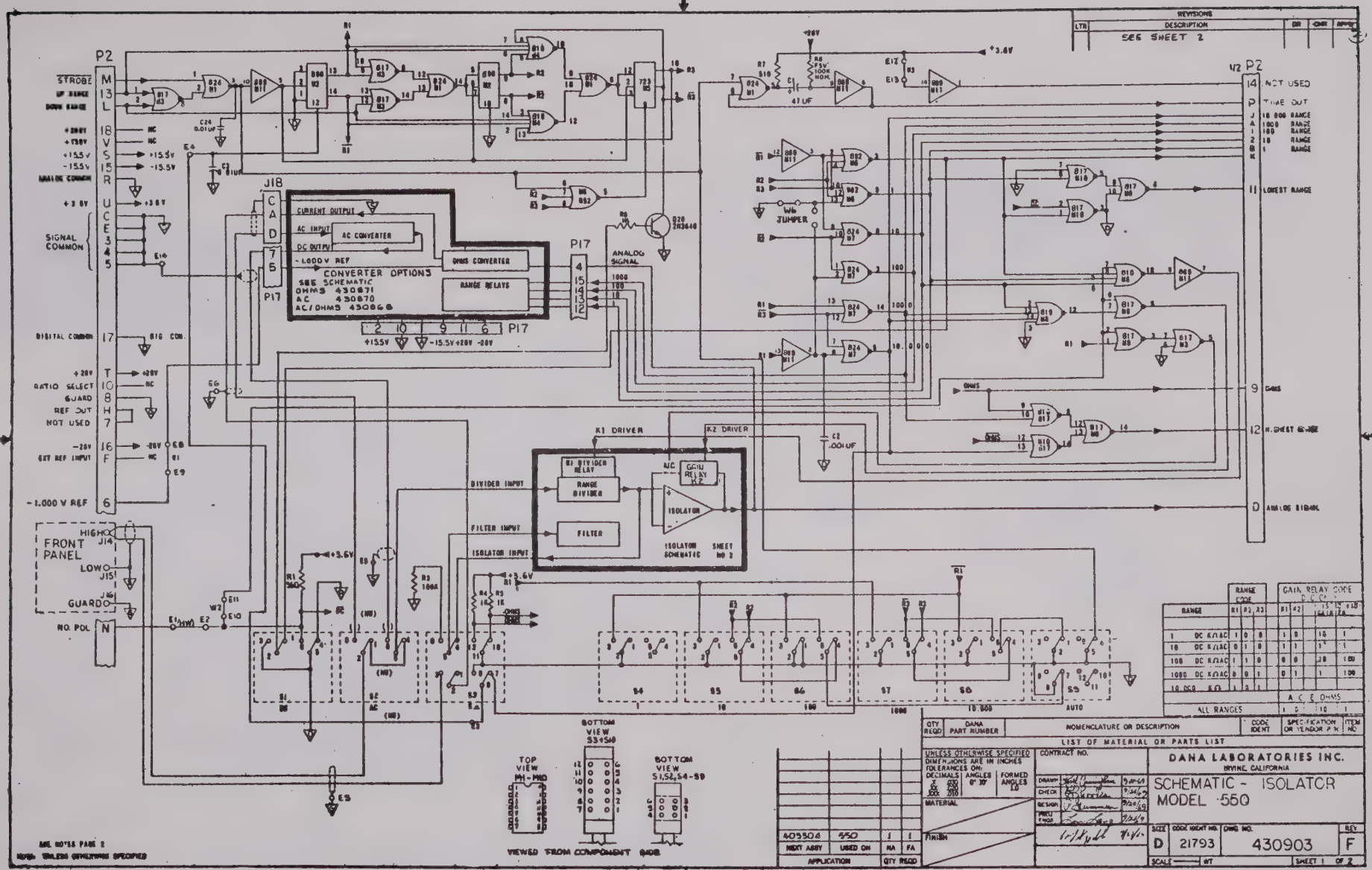
DANA DANA LABORATORIES INC IRVINE CALIFORNIA

PC BOARD ASSY
ISOLATOR MODEL 550

SIZE	CODE IDENT NO	DWG NO	REV
D	21793	403304	M

SCALE 2:1 SHEET 3 OF 8

SHEETS 4,5,6,7&8, 'M' SIZE



REVISIONS			
LTR	DESCRIPTION	DIR	DATE
	SEE SHEET 2		

RANGE	RANGE CODE R1	R2	R3	GAIN RELAY CODE K1	K2
1 DC K/AC	1	0	0	1	0
10 DC K/AC	0	1	0	1	1
100 DC K/AC	1	1	0	0	0
1000 DC K/AC	0	0	1	0	1
10 OHM K/Ω	1	1	1	A C E OHMS	
ALL RANGES				1	10

QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.

LIST OF MATERIAL OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON: DECIMALS .XX ±.03 .XXX ±.010 ANGLES ±0° 30' FORMED ANGLES ±0

MATERIAL

FINISH

CONTRACT NO.

DRAWN			9-20-63
CHECK			9/20/63
DESIGN			9/20/63
PROJ ENGR			9/20/63

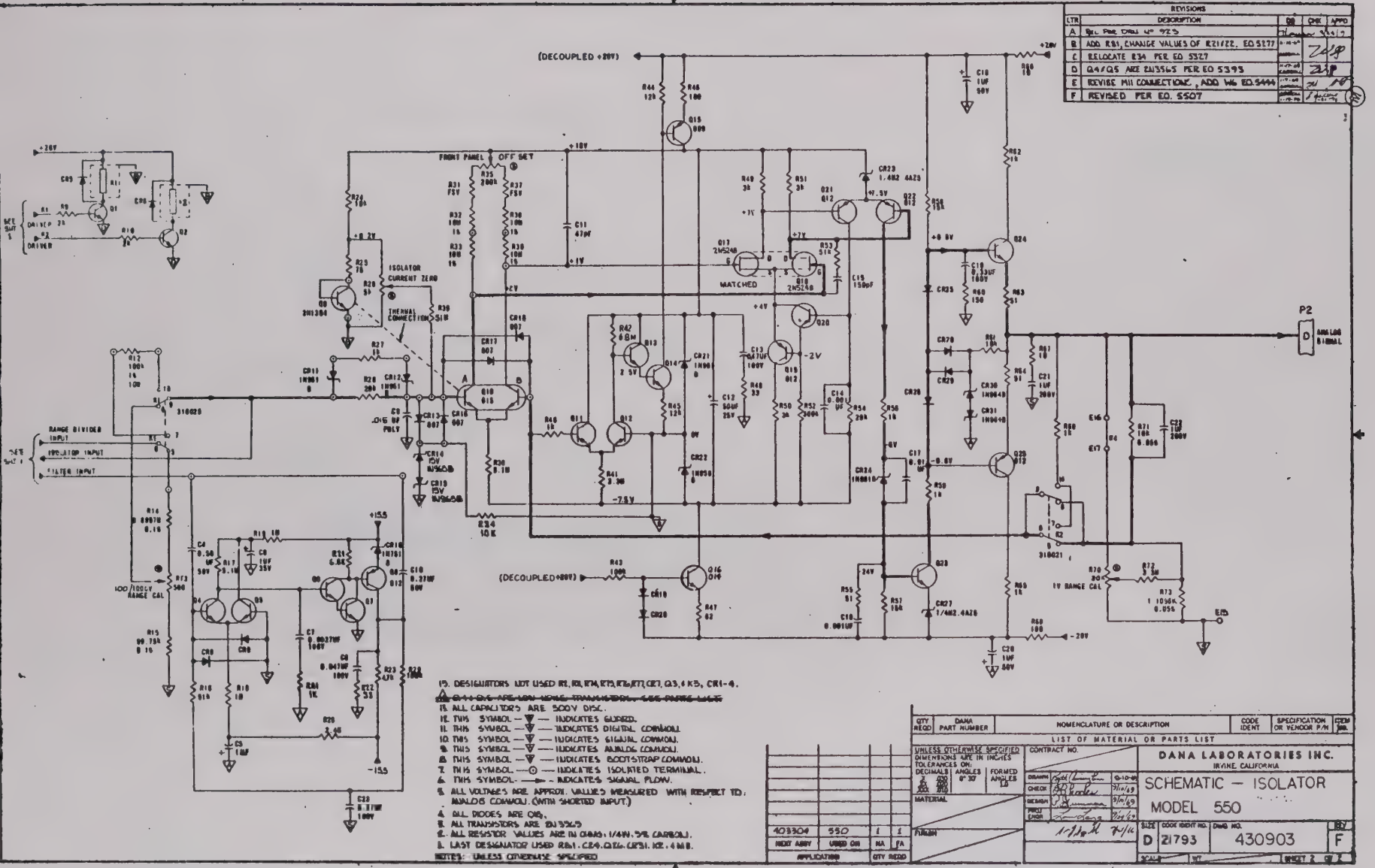
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC - ISOLATOR
MODEL 550

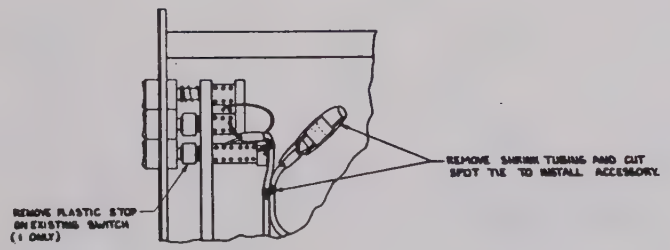
SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	430903	F

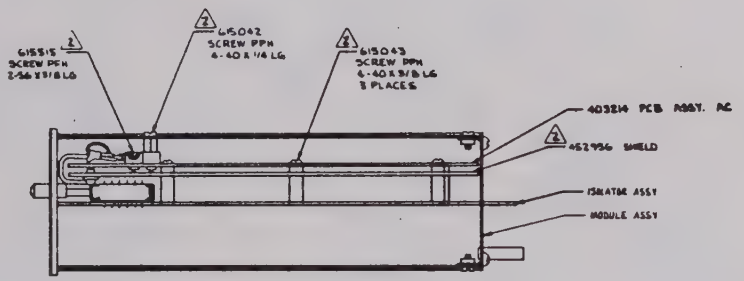
SCALE — WT — SHEET 1 OF 2

403904	550	J	L
NEXT ASSY	USED ON	RA	FA
APPLICATION		QTY REQD	


REVISIONS
LTR | DESCRIPTION | DR | CHK | APPD
A | REL FOR DRN Nº 923
B | ADD R81, CHANGE VALUES OF R2122, EO 5277
C | RELOCATE R34 PER EO 5327
D | Q4/Q5 ARE 2N3565 PER EO 5393
E | REVISE MII CONNECTIONS, ADD W6 EO 5444
F | REVISED PER EO. 5507
(DECOUPLED +20V)
(DECOUPLED +80V)
FRONT PANEL OFF SET
ISOLATOR CURRENT ZERO
THERMAL CONNECTION
MATCHED
P2
RANGE DIVIDER INPUT
ISOLATOR INPUT
FILTER INPUT
100 /1000V RANGE CAL
1V RANGE CAL
-15.5
-7.5V
-2V
-20V
15. DESIGNATORS NOT USED R1, R2, R14, R73, R76, R77, CR7, Q3, 4 K5, CR1-4.
16. ALL CAPACITORS ARE 500V DISC.
17. THIS SYMBOL — — INDICATES GUARD.
18. THIS SYMBOL — — INDICATES DIGITAL COMMON.
19. THIS SYMBOL — — INDICATES SIGNAL COMMON.
20. THIS SYMBOL — — INDICATES ANALOG COMMON.
21. THIS SYMBOL — — INDICATES BOOTSTRAP COMMON.
22. THIS SYMBOL — — INDICATES ISOLATED TERMINAL.
23. THIS SYMBOL — — INDICATES SIGNAL FLOW.
24. ALL VOLTAGES ARE APPROX. VALUES MEASURED WITH RESPECT TO ANALOG COMMON. (WITH SHORTED INPUT.)
25. ALL DIODES ARE 1N3605.
26. ALL TRANSISTORS ARE 2N3565.
27. ALL RESISTOR VALUES ARE IN OHMS, 1/4W, 5% CARBON.
28. LAST DESIGNATOR USED R81, C29, Q26, CR31, K2, MB.
NOTES: UNLESS OTHERWISE SPECIFIED
QTY REQD | DANA PART NUMBER | NOMENCLATURE OR DESCRIPTION | CODE IDENT | SPECIFICATION OR VENDOR P/N | ITEM NO.
LIST OF MATERIAL OR PARTS LIST
403904 | 550 | 1 | 1
NEXT ASSY | USED ON | NA | FA
APPLICATION | QTY REQD
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON: DECIMALS .XX ±.02 .XXX ±.010 ANGLES 0° 30' FORMED ANGLES ±2°
MATERIAL
FINISH
CONTRACT NO.
DRAWN
CHECK
ENGR
PROJ ENGR
DANA LABORATORIES INC.
IRVINE, CALIFORNIA
SCHEMATIC — ISOLATOR
MODEL 550
SIZE D | CODE IDENT NO. 21793 | DWG NO. 430903 | REV F
SCALE | WT | SHEET 2 OF 2

REVISIONS				
LTR	DESCRIPTION	DR	CHK	APPD
	RELEASED PER DRN # 895			
B	SPOT TIE COAX TO SWITCH EO 5143			
C	DELETE P/N FOR SOLATOR AND ASSY MODULE PER EO 5386			
D	REVISE CABLE VIEW PER EO 5498			




615515 SCREW PPH 2-56 X 7/16 LG
615042 SCREW PPH 4-40 X 1/4 LG
615043 SCREW PPH 4-40 X 3/8 LG 3 PLACES
403214 PCB ASSY. AC
462956 SHIELD
ISOLATOR ASSY
MODULE ASSY

SIDE EXTRUSION REMOVED FOR CLARITY

⚠ ALL INSTALLED HARDWARE TO BE KEPT IN ENVIRONMENTAL KIT (403203)

1 ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM TO DANA WORKMANSHIP STANDARDS

NOTES: UNLESS OTHERWISE SPECIFIED

403293	5200	1	1
403201	4500	1	1
NEXT DWG	USED ON		
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES

DECIMALS	ANGLES	HOLE DIAMETERS
X .030	± 30'	+ .004
.XX .020	FORMED ± 0°	- .001
.XXX .010		

DIMENSIONS AND TOLERANCES PER USAS Y14.5

MATERIAL | FINISH

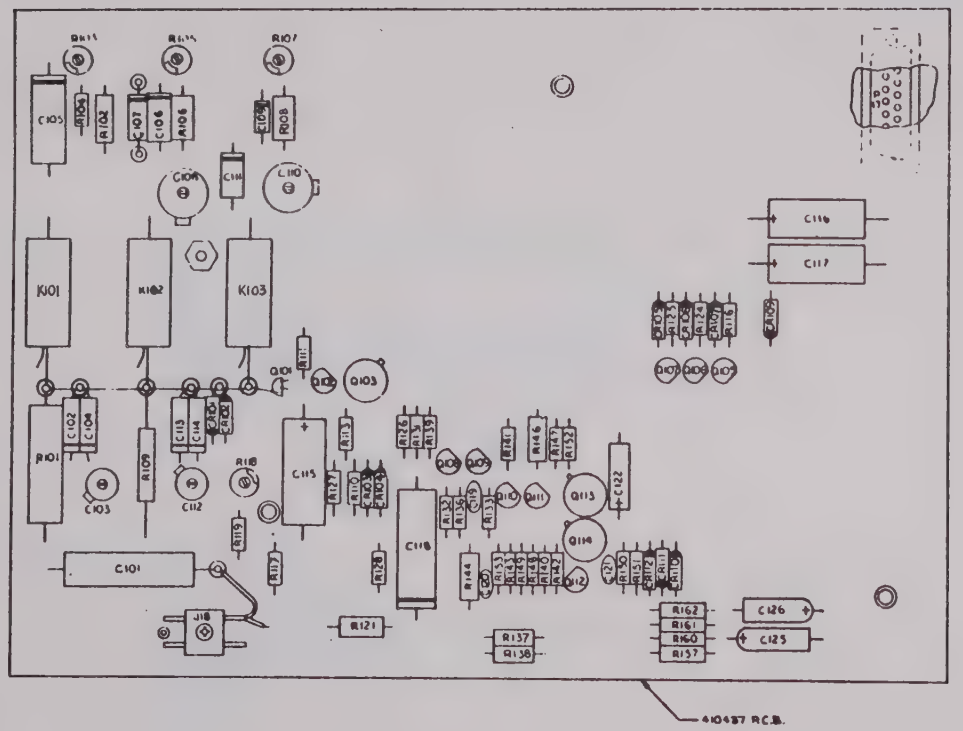
DRAWN		4/13/15
CHECK		
ENGR		4/13/15
MFG ENGR		
PROJ ENGR		5/16/15
PROJ ENGR		

DANA DANA LABORATORIES INC. IRVINE, CALIFORNIA

ASSY- A.C. ACCESSORY

SIZE	CODE IDENT NO	DWG NO	REV
D	21793	403203	D

SCALE 1/1 SHEET 1 OF 2



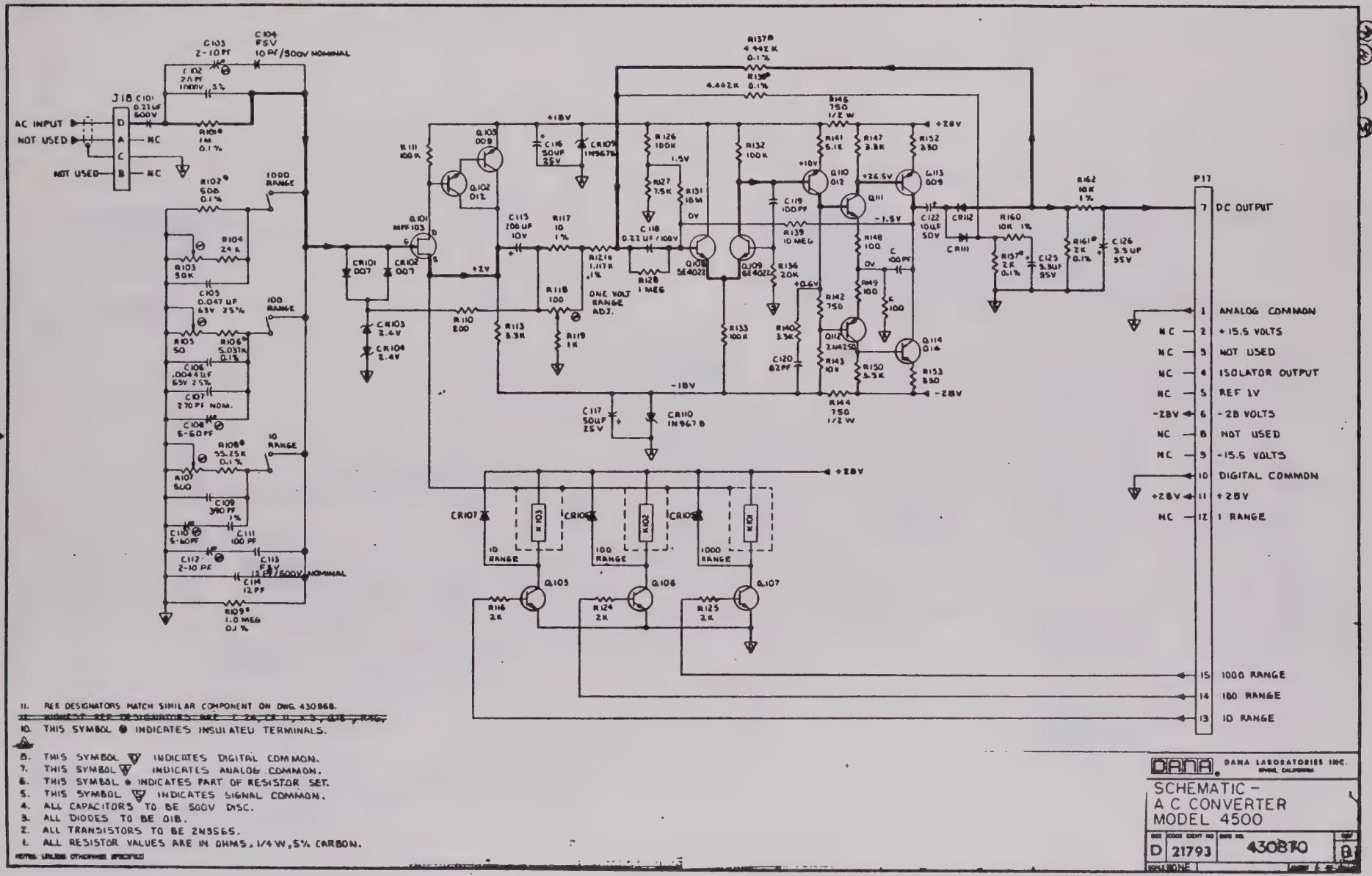
2. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM TO DANA WORKMANSHIP STANDARDS.
1. REF SCHEMATIC NO. 490870.
NOTES UNLESS OTHERWISE SPECIFIED

DANA LABORATORIES INC.
IRVINE CALIFORNIA

P.C.B. ASSEMBLY
A.C. CONVERTER

SIZE	CODE IDENT NO	DWG NO	REV
D	21793	403214	F

SCALE | SHEET



11. REF DESIGNATORS MATCH SIMILAR COMPONENT ON DWG 430868.
~~12. HIGHEST REF DESIGNATORS ARE C 24, CR 11, R 3, Q 18, J, RAG.~~
10. THIS SYMBOL ● INDICATES INSULATED TERMINALS.

⚠

8. THIS SYMBOL ▽ INDICATES DIGITAL COMMON.
7. THIS SYMBOL ▽ INDICATES ANALOG COMMON.
6. THIS SYMBOL * INDICATES PART OF RESISTOR SET.
5. THIS SYMBOL ▽ INDICATES SIGNAL COMMON.
4. ALL CAPACITORS TO BE 500V DISC.
3. ALL DIODES TO BE 018.
2. ALL TRANSISTORS TO BE 2N3565.
1. ALL RESISTOR VALUES ARE IN OHMS, 1/4 W, 5% CARBON.

UNLESS OTHERWISE SPECIFIED

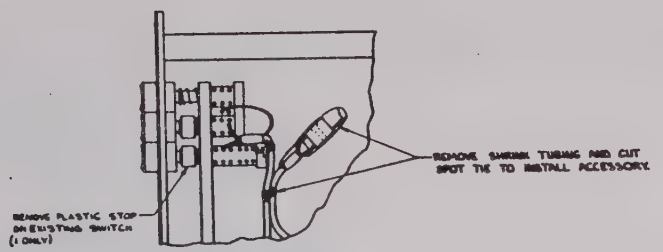
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

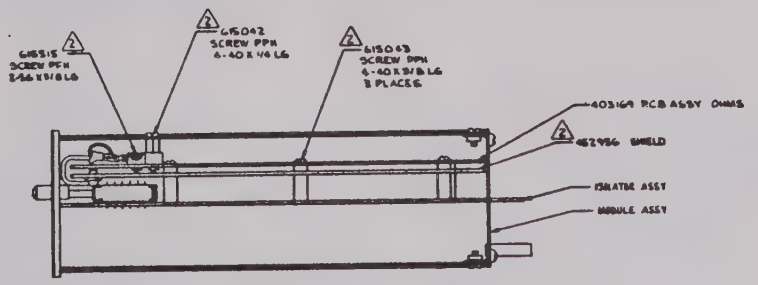
SCHEMATIC –
A C CONVERTER
MODEL 4500

SIZE	CODE IDENT NO	DWG NO	REV
D	21793	430870	B

ISSUE NONE

REVISIONS				
LTR	DESCRIPTION	DR	CHK	APPD
	RELEASED PER DRN [illegible]	[illegible]	[illegible]	[illegible]
B	SPOT TIE COAX TO SWITCH ED 5493	[illegible]	[illegible]	[illegible]
C	DELETE P/N PER ISOLATOR AND ASSY MODULE PER ED 5586	[illegible]	[illegible]	[illegible]
D	REVISE CABLE VIEW PER ED 6498	[illegible]	[illegible]	[illegible]





SIDE EXTRUSION REMOVED FOR CLARITY

403293	5200	1	1
403201	4900	1	1

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES

DIMENSIONS AND TOLERANCES PER USAS Y14.5M

DANA LABORATORIES INC. IRVINE, CALIFORNIA

ASSY- OHMS ACCESSORY

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	403228	D

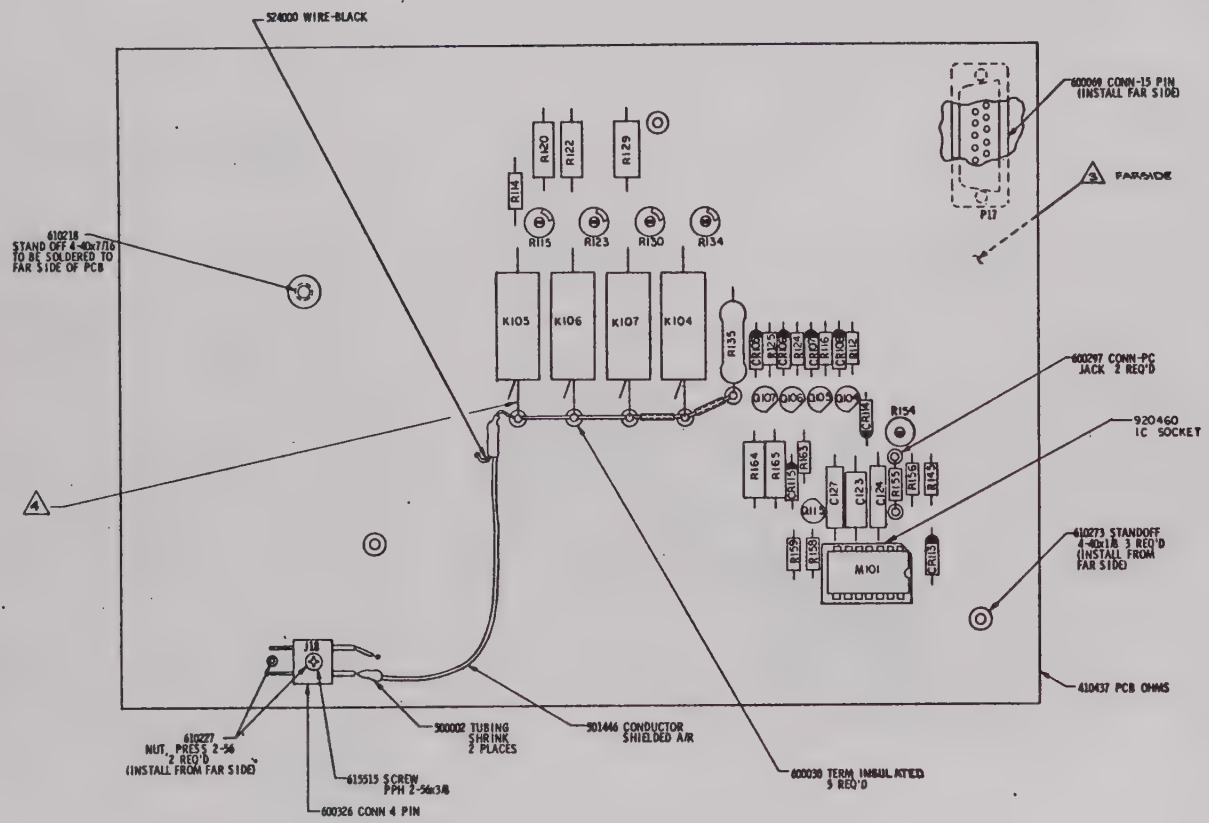
SCALE 1/1 SHT 2 OF 2

SHT 2 IS AN 'A' SIZE

⚠ ALL INDICATED HARDWARE IS INCLUDED IN FINISHING KIT (403227)

1. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM TO DANA WORKMANSHIP STANDARDS.

NOTES: UNLESS OTHERWISE SPECIFIED



REF DES OR ITEM	P/N	DESCRIPTION	QTY
C123	121088	CAP 0.01 UF 100V	1
C124	121146	CAP 0.0047 UFT 100V	2
C127	121146	CAP 0.0047 UF/100V	REF
	500378	SLEEVING WIRE TEF	A/R
	500043	COATED BUSS	A/R
CR108	211083	DIODE 018	4
CR107	211083	DIODE 018	REF
CR106	211083	DIODE 018	REF
CR105	211083	DIODE 018	REF
CR113	221177	1N M 2.4 AZ5	3
CR114	221177	1N M 2.4 AZ5	REF
CR115	221177	1N M 2.4 AZ5	REF
K104	310036	RELAY	4
K105	310036	RELAY	REF
K106	310036	RELAY	REF
K107	310036	RELAY	REF
M101	230026	IC MC709C	1
Q113	200043	TSTR 2N3565	5
Q104	200043	TSTR 2N3565	REF
↓	↓	↓	↓
Q107	200043	TSTR 2N3565	REF
R112	000202	RES 2K	4
R114	001737	RES FSV (680K NOM	2
R115	040159	POT 500K	1
R116	000202	RES 2K	REF
R120	020494	RES 8.19K 0.1%	1
R122	020495	RES 89.81K 0.1%	1
R123	040115	POT 500 OHM	1

REF DES OR ITEM	P/N	DESCRIPTION	QTY
R124	000202	RES 2K	REF
R129	020496	RES 996.15K 0.1%	1
R130	040097	POT 5K	1
R125	000202	RES 2K	REF
R134	040104	POT 50K	1
R135	010357	RES 8.981M 0.1%	1
R143	000685	RES 6.8M	1
R154	040088	POT 100K 10%	1
R155	001737	RES FSV (5.1M NOM	REF
R156	000152	RES 1.5K	1
R159	000821	RES 820 OHM	1
R158	000512	RES 5.1K	1
R163	000912	RES 9.1K	1
R164	020090	RES 9K 0.01%	1
R165	021395	RES 1K 0.01%	1
	920460	I.C. SOCKET	1
	410437	PCB AC & OHMS	1
	430871	SCHEMATIC	REF
	500002	TUBING SHRINK	A/R
	500004	WIRE-BUSS 22 GA	A/R
	501446	CONDUCTOR SHIELDED	A/R
	524000	WIRE-BLACK	A/R
	600030	TERM ISOLATED	5
	600069	CONN-15 PIN	1
	600297	CONN-PC JACK	2
	600326	CONN 4 PIN	1
	610218	STANDOFF, 4-40x7/16	1
	610227	NUT-PRESS 2-56	2
	610273	STANDOFF, 4-40x1/8	3
	615515	SCREW, PFH 2-56x3/8	1
	620026	SOLDER WIRE	A/R

4. DO NOT BEND OR PULL RELAY LEADS, SOLDER DIRECTLY TO TERMINALS.

3. LEADS TO BE CUT SO THAT NONE EXTEND BEYOND .062, (1/16") FROM THE CIRCUIT SIDE OF THE BOARD (FARSIDE)

2. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM TO DANA WORKMANSHIP STANDARDS

1. SCHEMATIC REFERENCE 430871

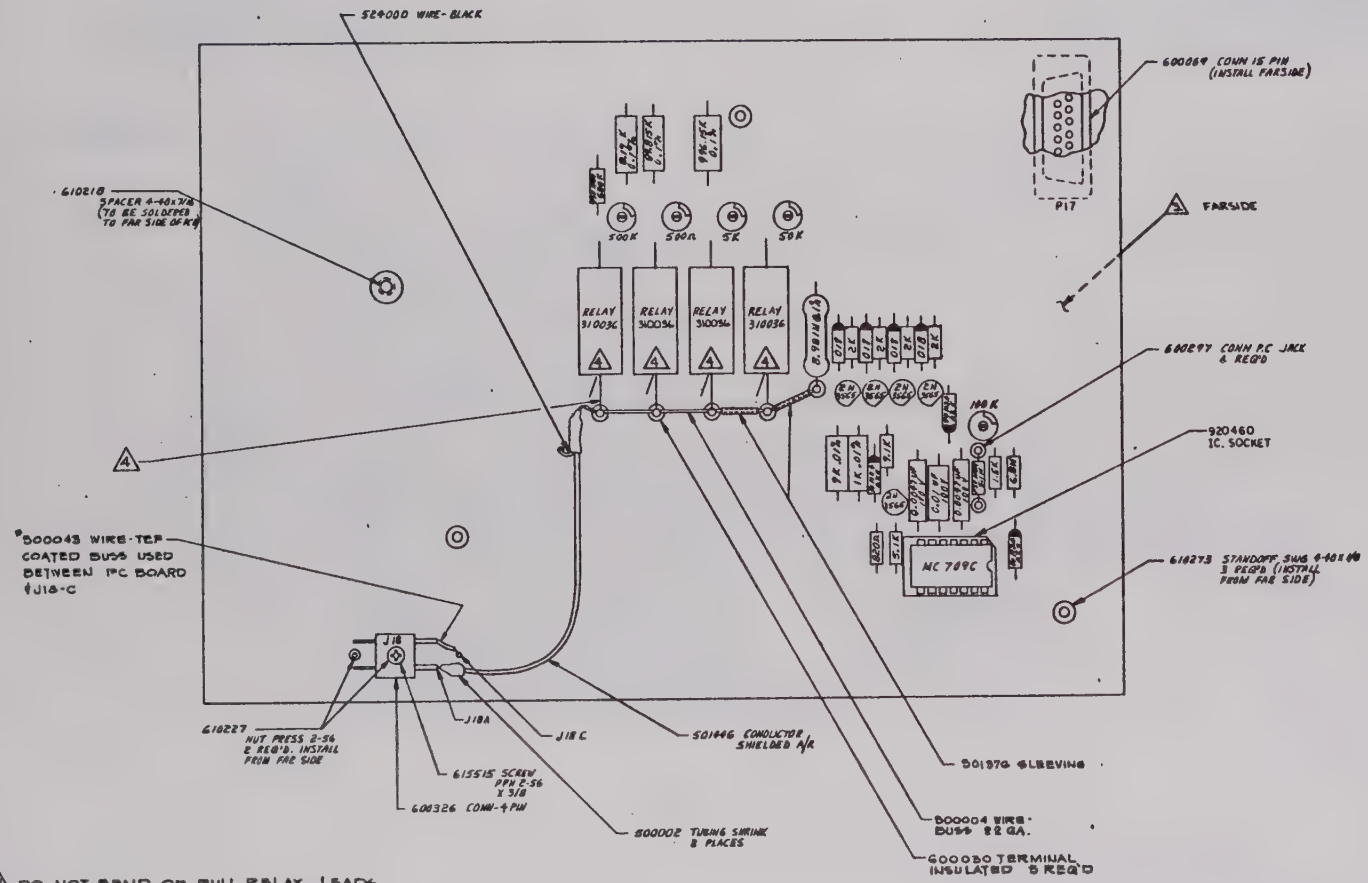
NOTES: UNLESS OTHERWISE SPECIFIED

DANA DANA LABORATORIES INC. IRVINE, CALIFORNIA

ASSEMBLY
OHMS CONVERTER

SIZE	CODE IDENT NO	DWG NO.	REV
D	21793	403169	F

SCALE 2 - 1 SHEET 1 OF 2



⚠4 DO NOT BEND OR PULL RELAY LEADS, SOLDER DIRECTLY TO TERMINALS.

⚠3 LEADS TO BE CUT SO THAT NONE EXTEND BEYOND .062, (1/16") FROM THE CIRCUIT SIDE OF THE BOARD (FARSIDE)

2 ASSEMBLY PROCEDURES AND PROFESSES TO CONFORM WITH DANA WORKMANSHIP STANDARDS.

1 SCHEMATIC REFERENCE 430871.

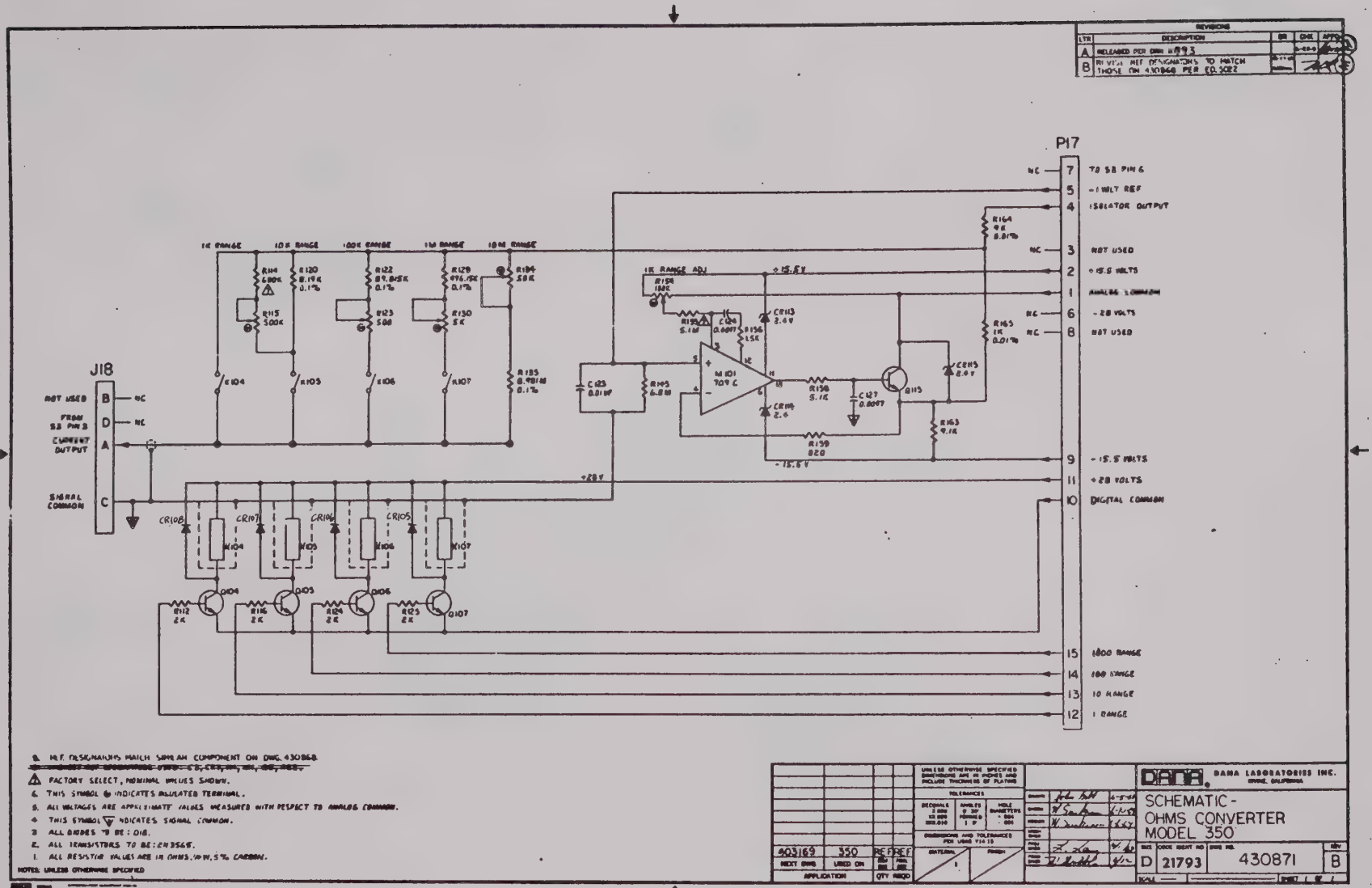
NOTES: UNLESS OTHERWISE SPECIFIED

DANA DANA LABORATORIES INC. IRVINE, CALIFORNIA

ASSEMBLY
OHMS CONVERTER

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	403169	F

SCALE 2 - 1 SHEET 2 OF 2



NOTES UNLESS OTHERWISE SPECIFIED

1. ALL RESISTOR VALUES ARE IN OHMS, 1/2W, 5% CARBON.
2. ALL TRANSISTORS TO BE: 2N3566.
3. ALL DIODES TO BE: 1N8.
4. THIS SYMBOL ▽ INDICATES SIGNAL COMMON.
5. ALL VOLTAGES ARE APPROXIMATE VALUES MEASURED WITH RESPECT TO ANALOG COMMON.
6. THIS SYMBOL ⊕ INDICATES INSULATED TERMINAL.
7. ⚠ FACTORY SELECT, NOMINAL VALUES SHOWN.
8. ~~M.F. DESIGNATIONS MATCH SIMILAR COMPONENT ON DWG. 430868.~~

NEXT DWG	USED ON	REF DES	QTY REQD
903169	350		

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING
TOLERANCES
DECIMALS 2 PLACE ±.03, 3 PLACE ±.010
ANGLES 0 DEC FRACTIONS ± 1°
HOLE DIAMETERS ±.004 ±.001
DIMENSIONS AND TOLERANCES PER USAS Y14.5
MATERIAL
FINISH

DRAWN John Bell 6-5-64
CHECKED W. Sullivan 6/10
ENGR W. Sullivan 6/6/67
MFG
QUAL
PROJ
APPD Earl Bell 6/6
APPD Earl Bell 6/6

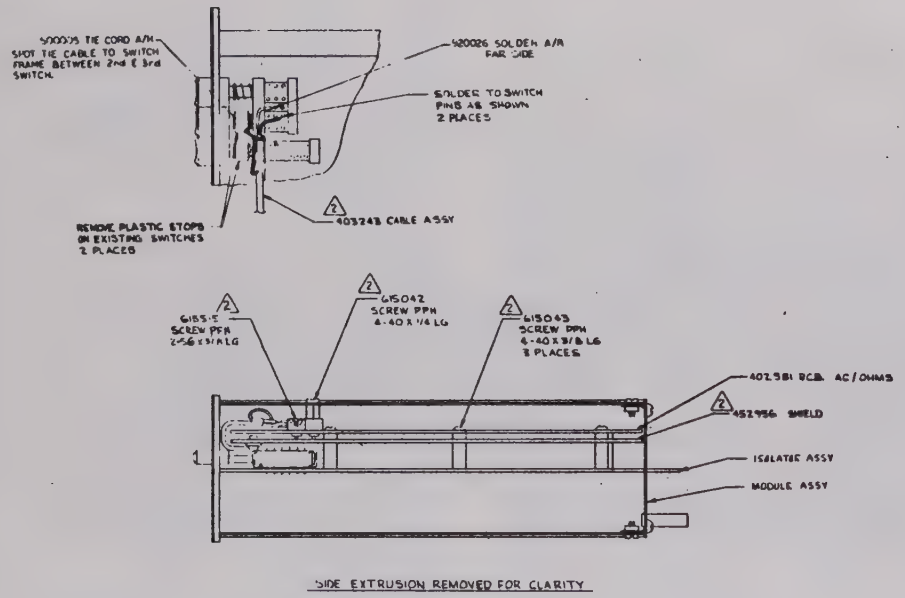
DANA LABORATORIES INC. IRVINE, CALIFORNIA

SCHEMATIC - OHMS CONVERTER MODEL 350

SIZE D | CODE IDENT NO 21793 | DWG NO 430871 | REV B

SCALE — | SHEET 1 OF 1

REVISIONS				
LTR	DESCRIPTION	DR	CHK	APP'D
A	RELEASED PER DRN #375 6-20-9			
B	SPOT TIE CABLE TO SWITCH PER EO 5345			
C	REMOVE P/N FOR ISOLATOR AND ASSY MODULE PER E.O. 5386			


500035 TIE CORD A/R
SPOT TIE CABLE TO SWITCH FRAME BETWEEN 2nd & 3rd SWITCH.
420026 SOLDER A/R FAR SIDE
SOLDER TO SWITCH PINS AS SHOWN 2 PLACES
2
403243 CABLE ASSY
REMOVE PLASTIC STOPS ON EXISTING SWITCHES 2 PLACES
2
615515 SCREW PFH 2-56 X 5/16 LG
2
615042 SCREW PPH 4-40 X 1/4 LG
2
615043 SCREW PPH 4-40 X 3/8 LG 3 PLACES
402581 PCB AC/OHMS
2
452956 SHIELD
ISOLATOR ASSY
MODULE ASSY
1

SIDE EXTRUSION REMOVED FOR CLARITY

⚠ ALL INDICATED HARDWARE IS INCLUDED IN FINISHING KIT (403227)

1 ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM TO DANA WORKMANSHIP STANDARDS

NOTES: UNLESS OTHERWISE SPECIFIED

NEXT DWG	USED ON	NEXT ASSY	FINISH SIZE
APPLICATION		QTY REQD	
	5200	1	1
	4300	1	1

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES

DECIMALS	ANGLES	HOLE DIAMETERS
X .030	0° 30' FORMED	+ .004
XX .010	1° 0'	- .001

DIMENSIONS AND TOLERANCES PER USAS Y14.5

MATERIAL | FINISH

DRAWN 4/13/62
CHECK
ENGR
CHECK ENGR
PROJ ENGR 4/16/62

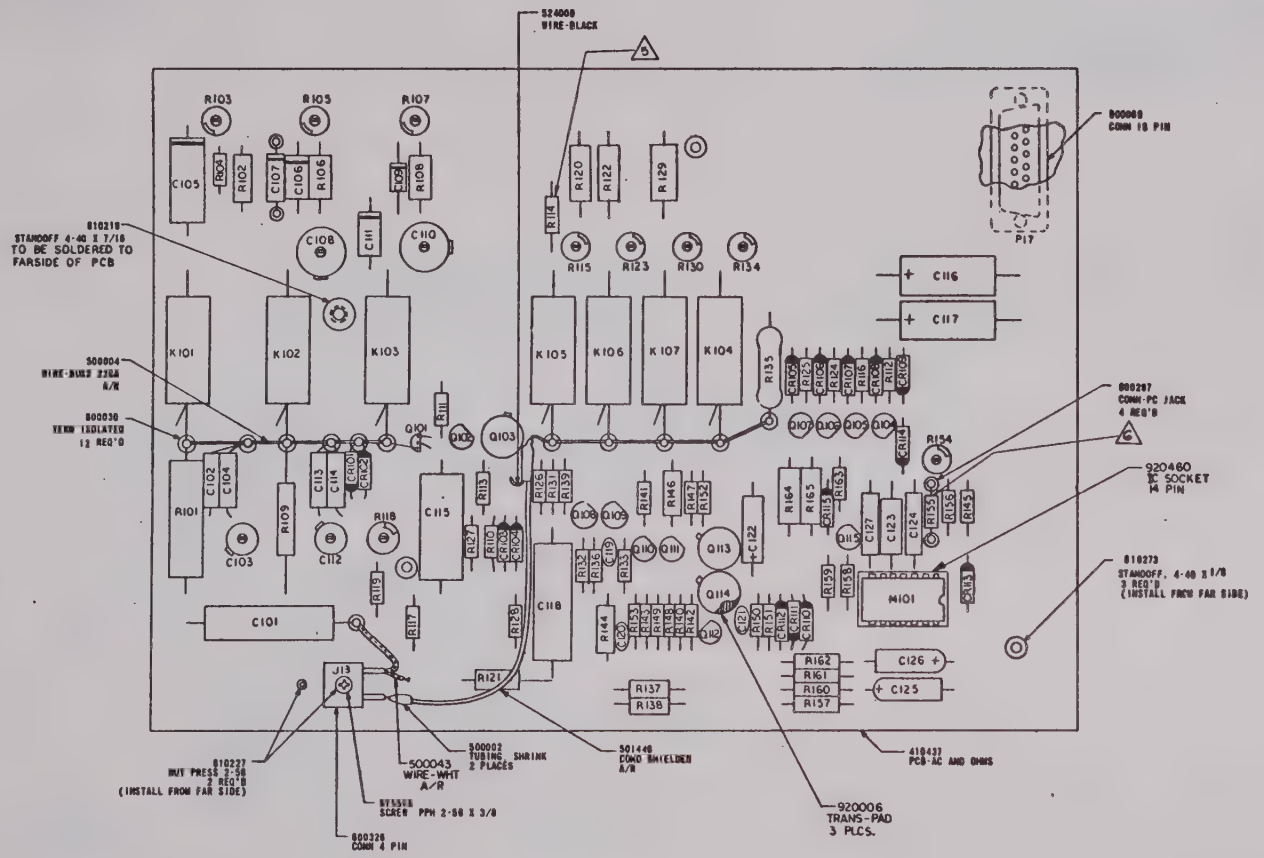
DANA DANA LABORATORIES INC. IRVINE, CALIFORNIA

ASSY AC/OHMS ACCESSORY

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	403229	C

SCALE 1/1 SHEET 1 OF 2

CUT 2 IS AN A SIZE



2. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM TO DANA WORKMANSHIP STANDARDS.
1. SCHEMATIC REFERENCE 430020

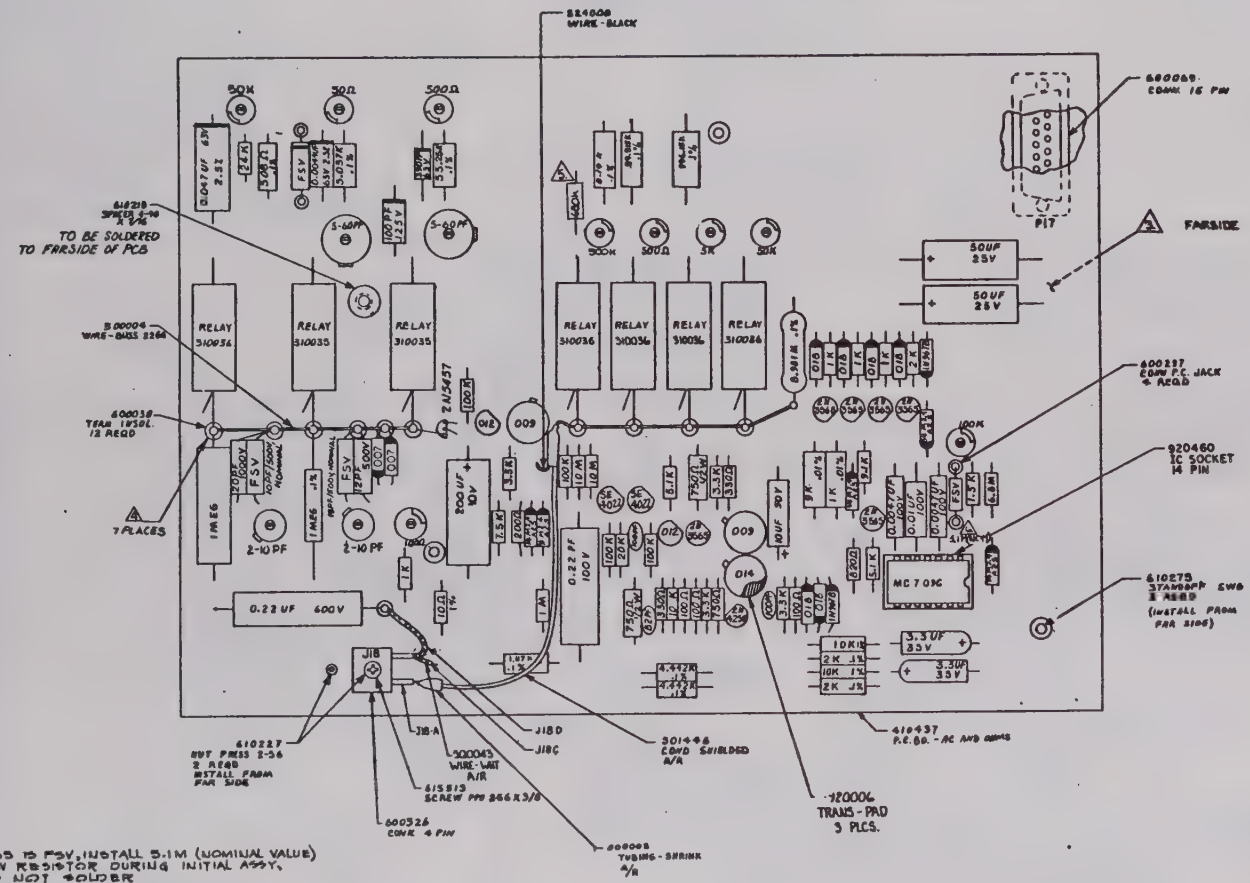
NOTES: UNLESS OTHERWISE SPECIFIED

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSY
A.C. & OHMS CONVERTER

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	402581	Y

SCALE 2:1 SHEET 1 OF 3



⚠ R155 IS FSV, INSTALL 5.1M (NOMINAL VALUE) 1/4W RESISTOR DURING INITIAL ASSY. DO NOT SOLDER

⚠ R114 IS FSV, INSTALL 680K (NOMINAL VALUE) 1/4W CC RESISTOR DURING INITIAL ASSY.

⚠ DO NOT WRAP RELAY LEADS AROUND TERMINALS

⚠ ALL COMPONENT LEADS MUST BE CUT SO THAT NONE EXTEND BEYOND .062" (1/16") FROM THE CIRCUIT SIDE OF THE BOARD (FARSIDE.)

2. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM WITH DANA WORKMANSHIP STANDARDS.

1 SCHEMATIC REFERENCE - 430823

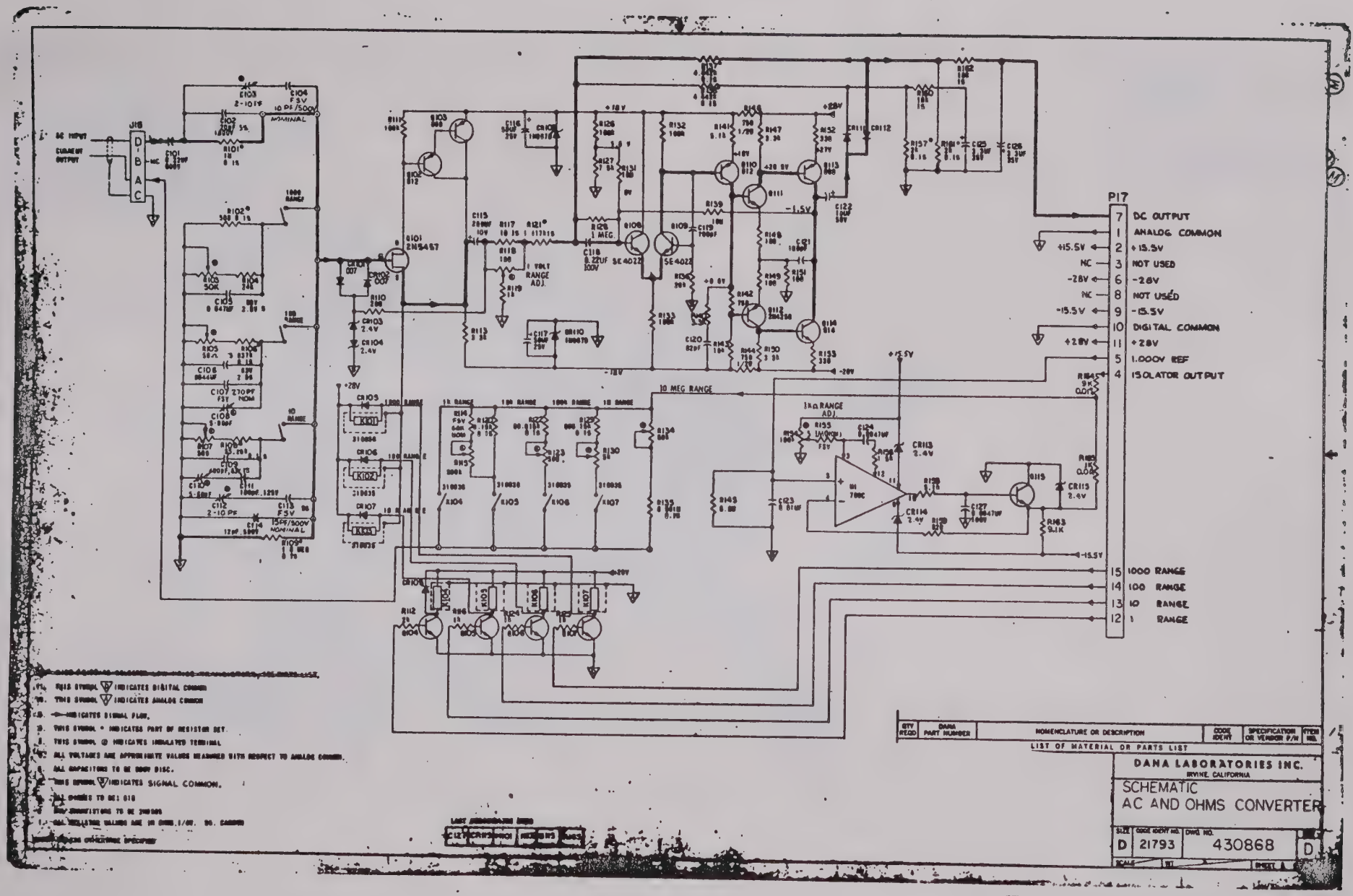
NOTES: UNLESS OTHERWISE SPECIFIED

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSY
A.C. & OHMS CONVERTER

SIZE	CODE IDENT NO	DWG NO.	REV
D	21793	402581	Y

SCALE 2:1 SHEET 2 OF 3



QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.

LIST OF MATERIAL OR PARTS LIST

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

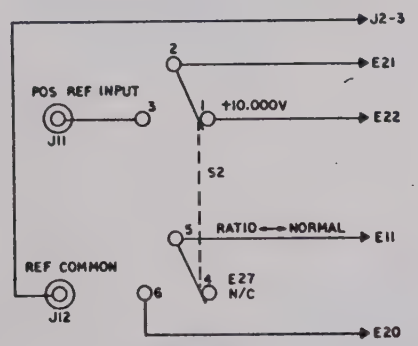
SCHEMATIC
AC AND OHMS CONVERTER

SIZE	CODE IDENT NO.	DWG. NO.	REV
D	21793	430868	D

SCALE | WT | SHEET 1

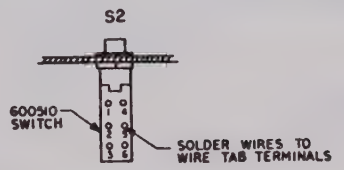
REVISIONS				
LTR	DESCRIPTION	DR	CHK	APPD
A	RELEASED PER DRN #			

SEE SHEET 1

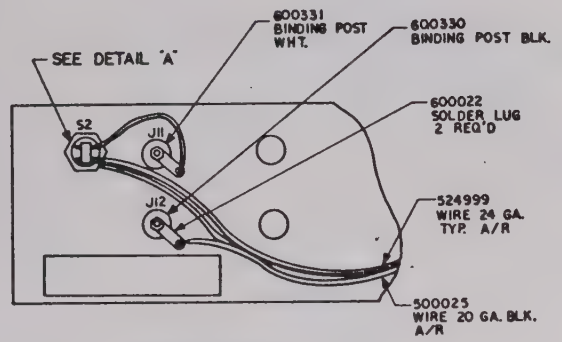


SCHEMATIC

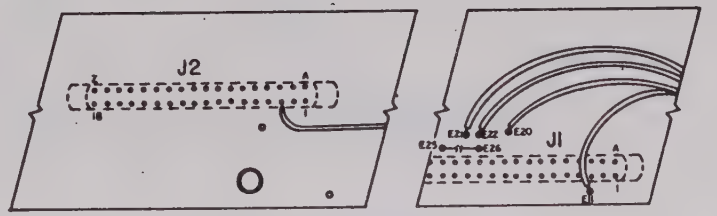
WIRING LIST		
SWITCH	TO	E NO.
S2-1		E22
S2-2		E21
S2-6		E20
S2-5		E11
S2-3		J11
BINDING POST		
J12		J2-3
J11		S2-3
CUT JUMPER FROM		
E25		E26



DETAIL A



REAR PANEL



POWER SUPPLY BOARD
REAR VIEW

FULL RACK

1. SEE NOTE 3, ON 4309H SCH. FOR RATIO CHANGE.

NOTES: UNLESS OTHERWISE SPECIFIED

NEXT DWG	USED ON	REQ'D PER ASSY	FINAL ASSY
	5230		
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES

DECIMALS	ANGLES	HOLE DIAMETERS
X .030	0 30'	- .004
XX .020	FORMED	- .001
XXX .010	1 0°	

DIMENSIONS AND TOLERANCES PER USAS Y14.5

MATERIAL | FINISH

DRAWN	Keith Cumpton	10/20/69
CHECK	R Hunter	10/21/69
DESIGN		69
MECH ENGR		
PROJ ENGR	L. Long	10/20/69
PROD ENGR	[illegible]	10/21/69

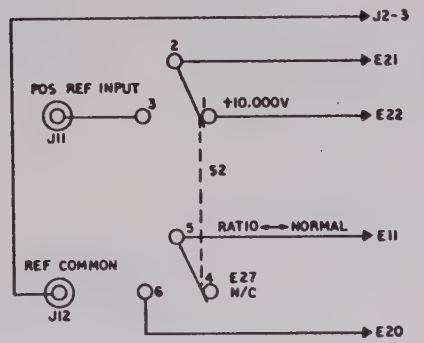
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSY RATIO

SIZE	CODE IDENT NO	DWG NO	REV
C	21793	403333	B

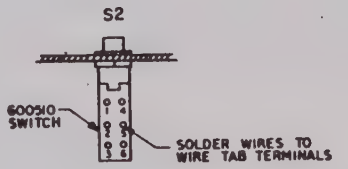
SCALE —— SHEET 2 OF 4

REVISIONS				
LTR	DESCRIPTION	DR	CHK	APPD
A	RELEASED PER DRN # 933			
B	REMOVE FUSE, ADD SHT 3, EO 5433			

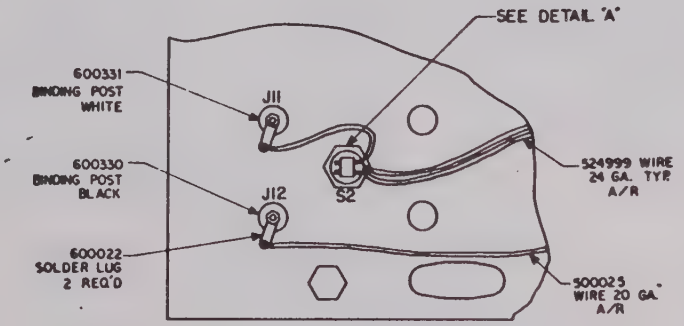


SCHEMATIC

WIRING LIST	
SWITCH	TO
S2-1	E22
S2-2	E21
S2-6	E20
S2-5	E11
S2-3	J11
BINDING POST	
J12	J2-3
J11	S2-3
CUT JUMPER FROM	
E25	E26

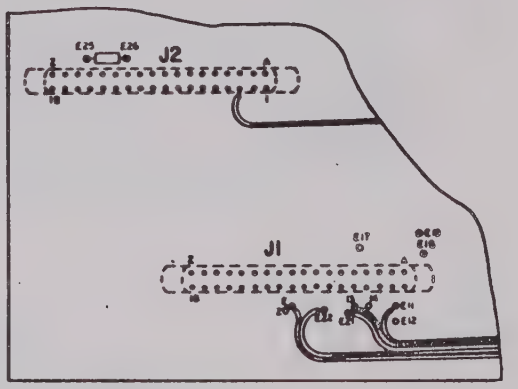


DETAIL A



REAR PANEL

HALF RACK



POWER SUPPLY BOARD
REAR VIEW

1. SEE NOTE 9, DWG 430911 SCH. FOR RATIO CHANGE.

NOTES: UNLESS OTHERWISE SPECIFIED

NEXT DWG	USED ON	QTY REQD
	5270	
APPLICATION		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES

DECIMALS	ANGLES	HOLE DIAMETERS
X .030	0° 30' FORMED	+ .004
XX .020	1° 0'	- .001
XXX .010		

DIMENSIONS AND TOLERANCES PER USAS Y14.15

MATERIAL | FINISH

DRAWN
CHECK
ENGRG
MECH ENGR
PROJ ENGR
PROD ENGR

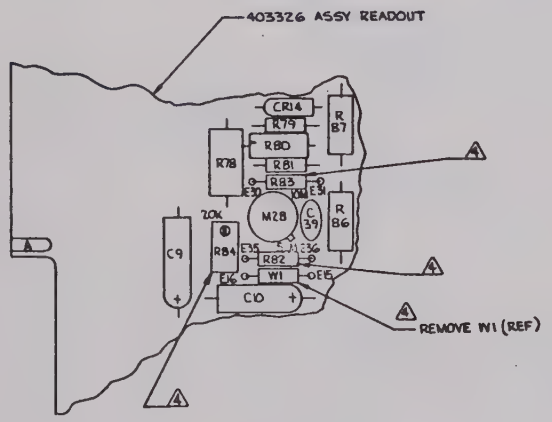
DANA DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSY RATIO

SIZE	CODE IDENT NO.	DWG NO.	REV
C	21793	403333	B

SCALE —— SHEET 1 OF 4

REVISIONS				
LTR	DESCRIPTION	DR	CHK	APPD
B	RELEASED PER DRN # 937			



NOTES: UNLESS OTHERWISE SPECIFIED

5 ALL OTHER COMPONENTS ARE FOR REF ONLY.

4 REMOVE JUMPER W1 & ADD R84, 20K. CHANGE THE VALUES OF R82 & R83 TO THOSE SHOWN ON FACE OF DWG.

3 ALL RESISTORS ARE IN OHMS ±5%, 1/4W CARBON.

2. SCHEMATIC REF 430911.

1. ASSEMBLY PROCEDURES & PROCESSES TO CONFORM TO DANA WORKMANSHIP STANDARDS.

NEXT DWG	USED ON	NEXT DWG	FINAL ASSY
	5270		
	5230		
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES

DECIMALS	ANGLES	HOLE DIAMETERS
X .030 XX .020 XXX .010	0° 30' FORMED 1° 0'	+ .004 - .001

DIMENSIONS AND TOLERANCES PER USAS Y14.15

MATERIAL | FINISH

DRAWN	P. Summers	11/21/69
CHECK	J. Tang	11/24
DESIGN	P. Summers	11/21/69
MECH ENGR		
PROJ ENGR	J. Tang	11/24
PROD ENGR	[illegible]	11/24/69

DANA DANA LABORATORIES INC.
IRVINE, CALIFORNIA

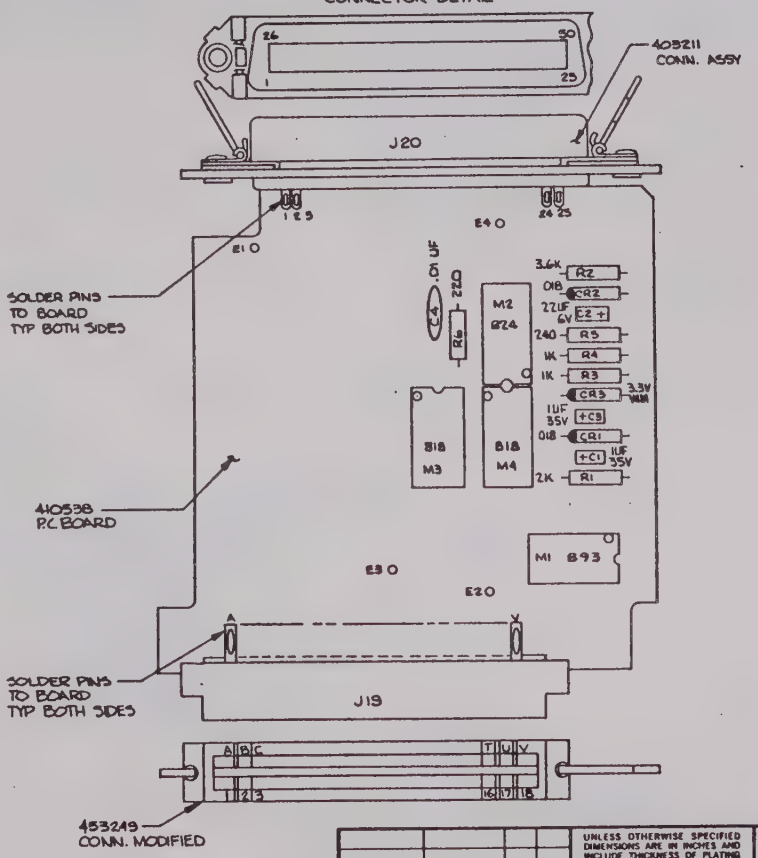
ASSY RATIO (READOUT)

SIZE	CODE IDENT NO.	DWG NO.	REV
C	21793	403333	B

SCALE 2/1 SHEET 3 OF 4

REVISIONS				
LTR	DESCRIPTION	DR	CHK	APPD
A	RELEASED PER DRN # 933			
B	430912 WAS 430919, EO. 5389			
C	ADD C4 & R6 PER EO 5699			

PARTIAL VIEW
CONNECTOR DETAIL



2. SCHEMATIC # 430912
1. ASSY PROCESSES AND PROCEDURES TO CONFORM TO DANA WORKMANSHIP STANDARDS.

NOTES: UNLESS OTHERWISE SPECIFIED

NEXT DWG	USED ON	NEXT ASSY	FINAL ASSY
—	3200	—	—
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES

DECIMALS	ANGLES	HOLE DIAMETERS
X .030 XX .020 XXX .010	0° 30' FORMED 1° 0"	+.004 −.001

DIMENSIONS AND TOLERANCES PER USAS Y14.15

MATERIAL | FINISH

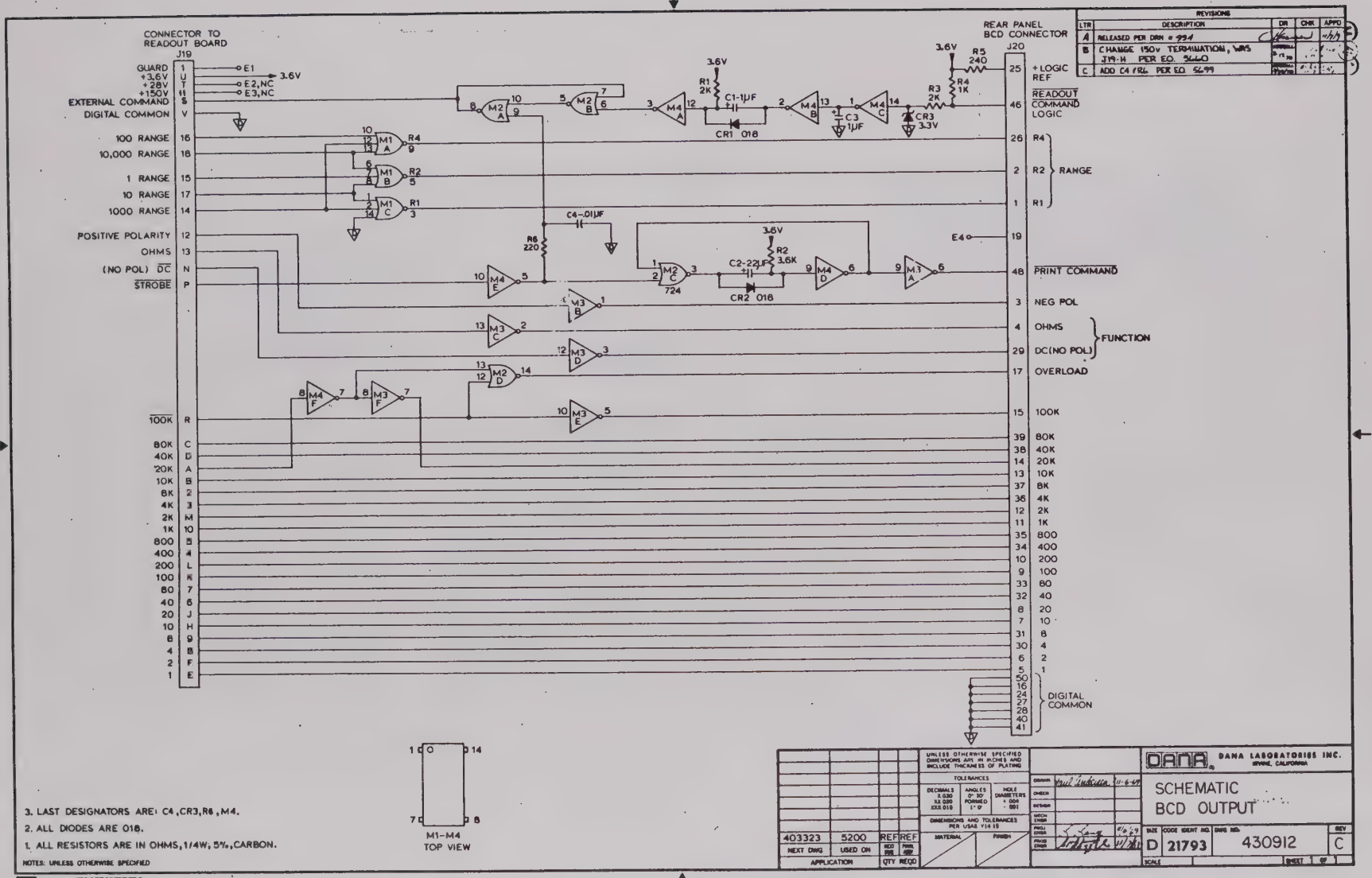
DRAWN		9-23-69
CHECK		9/24/69
DESIGN		10/20/69
MECH ENGR		
PROJ ENGR		10/20/69
PROD ENGR		10/20/69

DANA DANA LABORATORIES INC.
IRVINE, CALIFORNIA

PC BOARD ASSY
BCD OUTPUT

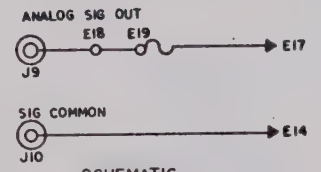
SIZE	CODE IDENT NO.	DWG NO.	REV
C	21793	403323	C

SCALE 2:1 SHEET 1 OF 2

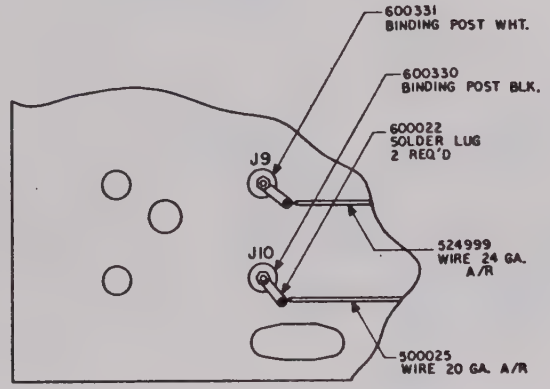

CONNECTOR TO READOUT BOARD
J19
REAR PANEL BCD CONNECTOR
J20
REVISIONS
LTR DESCRIPTION DR CHK APPD
A RELEASED PER DRN # 991
B CHANGE 150V TERMINATION, WAS J19-H PER EO. 3660
C ADD C4 FRL PER EO. 5699
GUARD
+3.6V
+28V
+150V
EXTERNAL COMMAND
DIGITAL COMMON
100 RANGE
10,000 RANGE
1 RANGE
10 RANGE
1000 RANGE
POSITIVE POLARITY
OHMS
(NO POL) DC
STROBE
100K
80K
40K
20K
10K
8K
4K
2K
1K
800
400
200
100
80
40
20
10
8
4
2
1
E1
E2,NC
E3,NC
3.6V
R1 2K
R2 3.6K
R3 2K
R4 1K
R5 240
R6 220
C1-1μF
C2-22μF
C3 1μF
C4-01μF
CR1 018
CR2 018
CR3 3.3V
724
+LOGIC REF
READOUT COMMAND LOGIC
PRINT COMMAND
NEG POL
RANGE
FUNCTION
OVERLOAD
DIGITAL COMMON
M1-M4
TOP VIEW
3. LAST DESIGNATORS ARE: C4, CR3, R6, M4.
2. ALL DIODES ARE 018.
1. ALL RESISTORS ARE IN OHMS, 1/4W, 5%, CARBON.
NOTES: UNLESS OTHERWISE SPECIFIED
DANA LABORATORIES INC.
IRVINE, CALIFORNIA
SCHEMATIC
BCD OUTPUT
403323
5200
NEXT DWG
USED ON
APPLICATION
SIZE D
CODE IDENT NO. 21793
DWG NO. 430912
REV C
SCALE
SHEET

REVISIONS				
LTR	DESCRIPTION	DR	CHK	APPD
A	RELEASED PER DRN # 905 8-7-9	HANSSEN		
B	CHANGE WIRE LIST TO: J10 TO J2-3 & REDRAW PER EO. 5164	9-23-69		
C	CORRECT WIRING DIAGRAM RE-LABEL J1-J2 PER EO 5415			

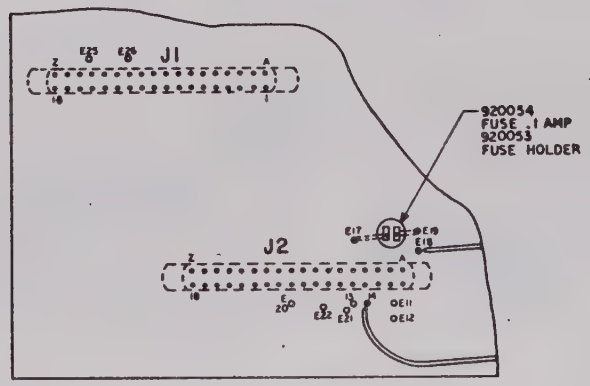
WIRING LIST		
FUSE	TO	E NO.
TERM 1		E17
TERM 2		E19
BINDING POST		
JACK	TO	E NO.
J9		E18
J10		E14



SCHEMATIC



REAR PANEL



POWER SUPPLY BOARD
REAR VIEW

HALF RACK

NOTES: UNLESS OTHERWISE SPECIFIED

	4530		
	4570		
NEXT DWG	USED ON	NEXT DWG	FINAL ASSY
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES

DECIMALS	ANGLES	HOLE DIAMETERS
X .030	0° 30'	+ .004
XX .020	FORMED	- .001
XXX .010	1° 0'	

DIMENSIONS AND TOLERANCES PER USAS Y14.15

MATERIAL | FINISH

DRAWN	B. CARROLL	9-19-69
CHECK	W. SARKISON	7-29-69
DESIGN	P. GUMMESON	7-29-69
MECH ENGR		
PROJ ENGR	W. SARKISON	7-30-69
PROD ENGR	P. SALERNO	7-31-69

DANA DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSY ANALOG SIGNAL OUTPUT

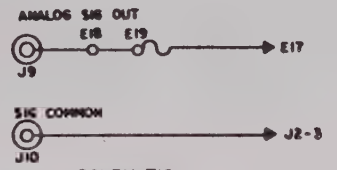
SIZE	CODE IDENT NO	DWG NO	REV
C	21793	403262	C

SCALE | SHEET 1 OF 3

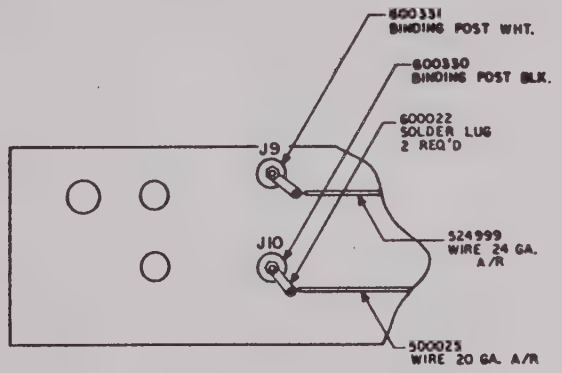
REVISIONS				
LTR	DESCRIPTION	DR	CHK	APPD
A	RELEASED PER DRN # 903 8-7-9	HANSSEN		

SEE SHEET 1

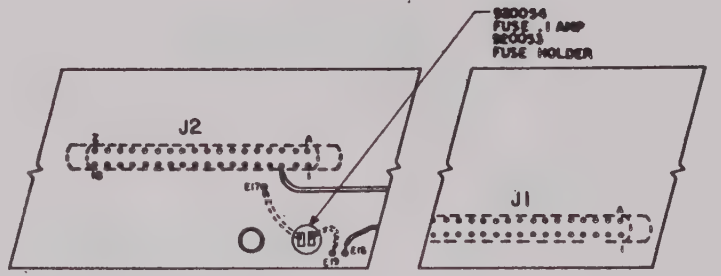
WIRING LIST		
FUSE	TO	E NO.
TERM 1		E17
TERM 2		E19
BINDING POST		
JACK	TO	E NO.
J9		E18
J10		J2-3



SCHEMATIC



REAR PANEL



POWER SUPPLY BOARD
REAR VIEW

FULL RACK

	4530		
	4570		
NEXT DWG	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES

DECIMALS	ANGLES	HOLE DIAMETERS
X .030	0° 30' FORMED	+ .004
XX .020		- .001
XXX .010	1° 0'	

DIMENSIONS AND TOLERANCES PER USAS Y14.5

MATERIAL | FINISH

DRAWN	R. CARROLL	6-15-68
CHECK	W. SARKISON	7-29-68
DESIGN	P. GUMMESON	7-29-68
MECH ENGR		
PROJ ENGR	W. SARKISON	7-30-68
PROD ENGR	R. SALERNO	7-31-68

DANA DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSY ANALOG SIGNAL OUTPUT

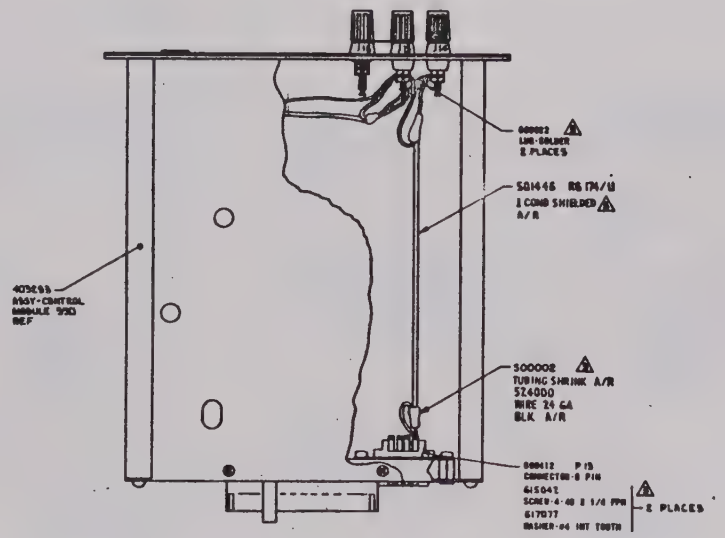
SIZE	CODE IDENT NO	DWG NO.	REV
C	21793	403262	C

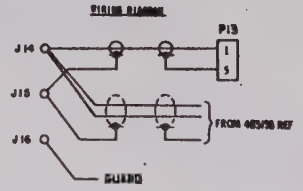
SCALE | SHEET 2 OF 3

NOTES: UNLESS OTHERWISE SPECIFIED

SHT 2 IS A SIZE

REVISIONS				
LTR	DESCRIPTION	DR	CHK	APPD
A	RELEASED PER DWN # [illegible]			





ALL HARDWARE IS INCLUDED IN REAR INPUT KIT 403209.

REPLACE PANEL 453212, WITH 453211, (PART OF REAR INPUT KIT).

1. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM TO [illegible]

NOTES UNLESS OTHERWISE SPECIFIED

	550	—	—	
NEXT DWG	USED ON	ASSY	FINAL	
APPLICATION		QTY REQD		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING.

TOLERANCES

DECIMALS	ANGLES	HOLE DIAMETERS
X.XX ± .020	0° 30'	+ .004
XX.X ± .010	FOR 2 D	- .001
XXX ± .010	1° 0'	

DIMENSIONS AND TOLERANCES PER USAS Y14.10-50

MATERIAL | FINISH

DRAWN	[signature]	8-27-71
CHECK	[signature]	9/24/71
DESIGN		
ENGR		
PROJ ENGR		
MFG ENGR	[signature]	10-4-71

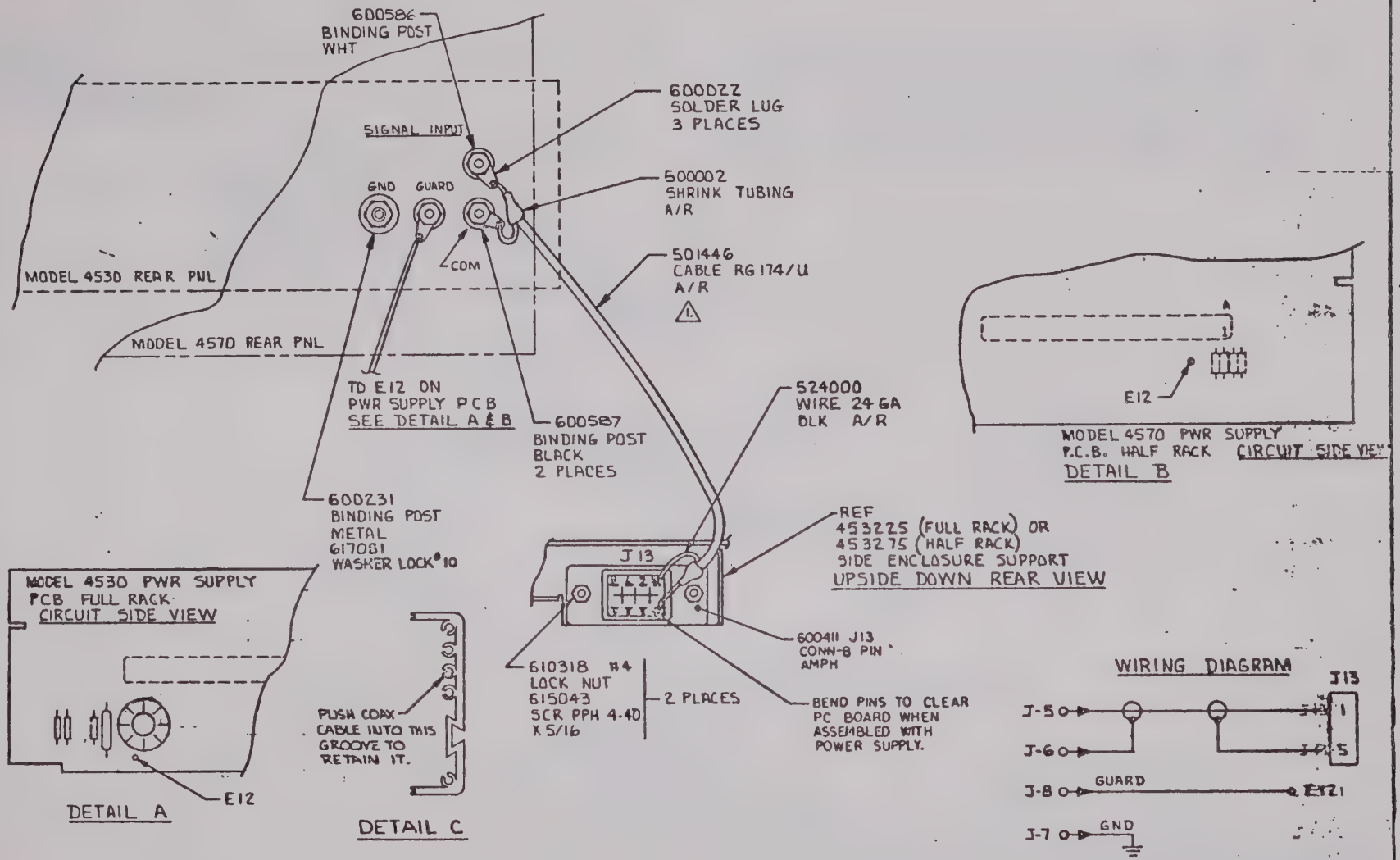
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ACCESSORY ASSY REAR INPUT MODEL 550

SIZE	CODE IDENT NO	DWG NO	REV
D	21793	403325	A

SCALE 1/1 SHEET 1 OF 2

UNIT 2 IS AN 'A' SIZE



⚠ SECURE COAX CABLE IN RECESS IN SIDE PANEL AS SHOWN IN DETAIL 'C'.

NOTES: UNLESS OTHERWISE SPECIFIED

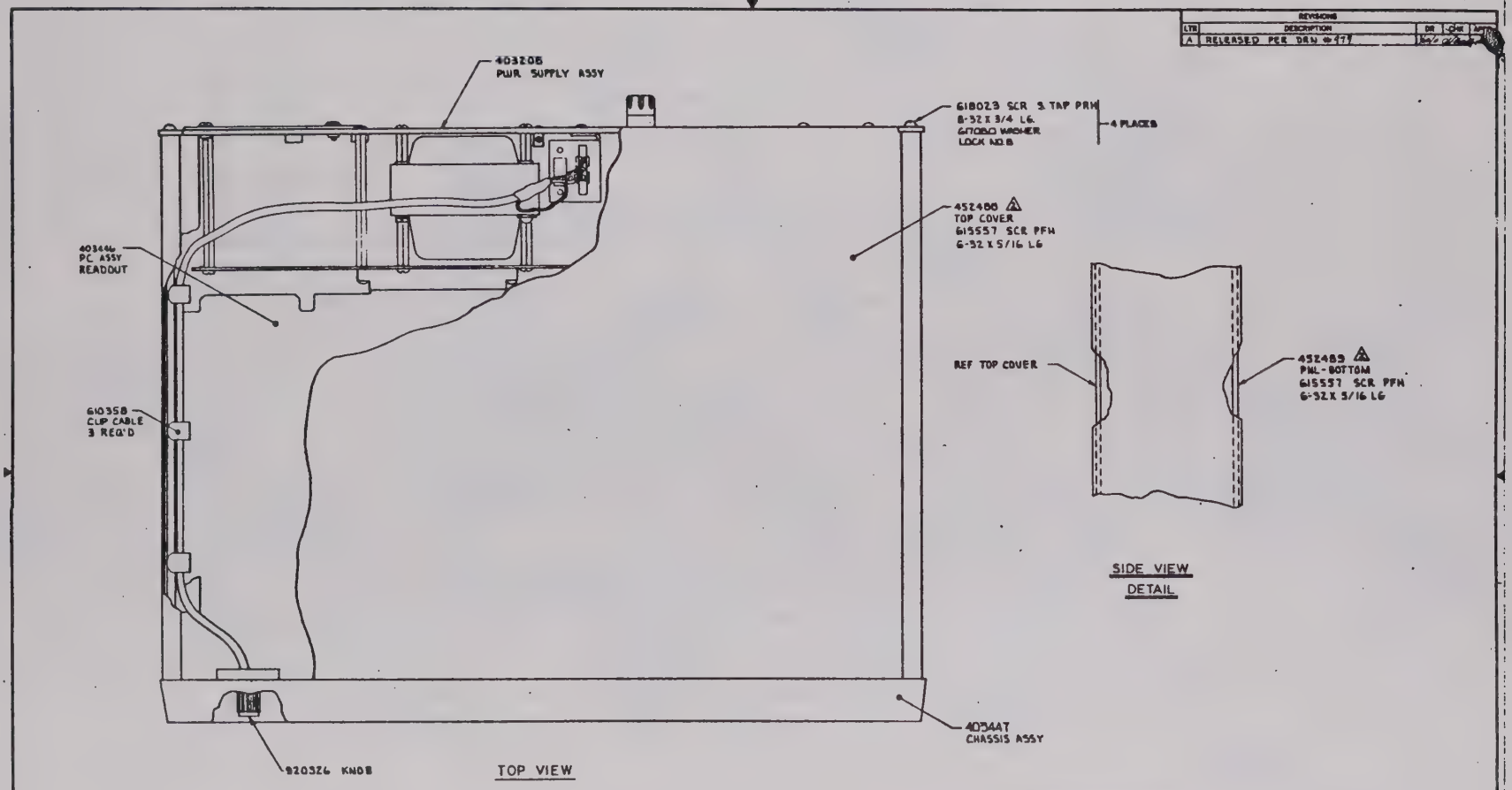
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSEMBLY – [illegible]
REAR INPUT.

SIZE	CODE IDENT NO.	DWG NO.	REV
C	21793	403230	E

SCALE 1/1

SHT 3



REVISIONS				
LTR	DESCRIPTION	DR	CHK	APP'D
A	RELEASED PER DRN # 779			

⚠ ALL INDICATED HARDWARE IS INCLUDED IN FINISHING KIT, (REF 403205).
1 ASSEMBLY PROCEDURE AND PROCESSES TO CONFORM WITH DANA WORKMANSHIP STANDARDS

	5330	—	—
NEXT ASSY	USED ON	RA	FA
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON: DECIMALS | ANGLES 0° 30' | FORMED ANGLES ±1°
.X ±.010 | .XX ±.005 | .XXX ±.010
MATERIAL
FINISH
CONTRACT NO.
DRAWN W. W. Young 1-15-70
CHECK
DESIGN
PROJ. ENGR.

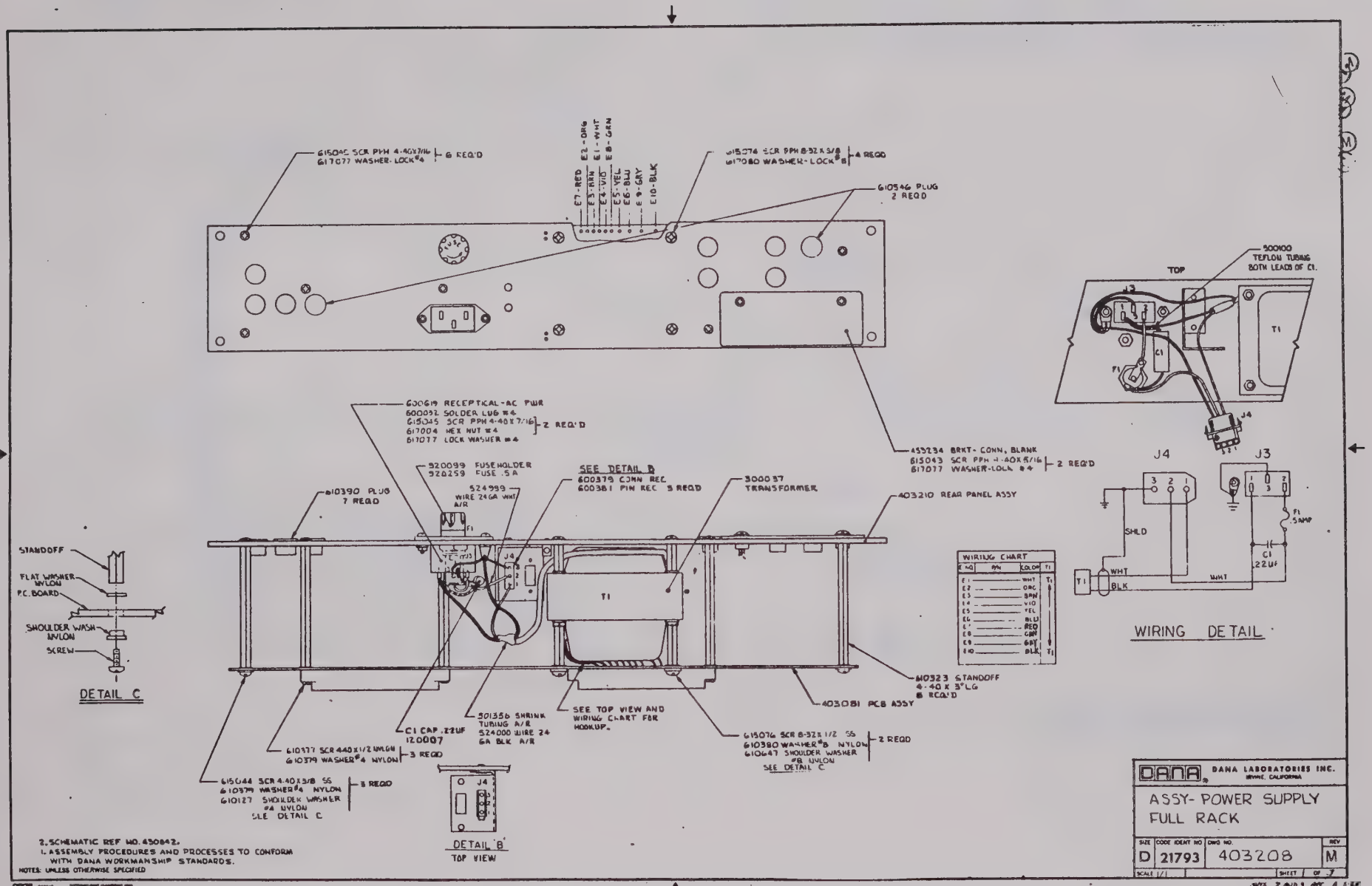
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSY - DVM 5330
FULL RACK

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	400962	A

SCALE 1/1 WT. SHEET 1 OF 2

SHT 2 "A" SIZE



NOTES: UNLESS OTHERWISE SPECIFIED

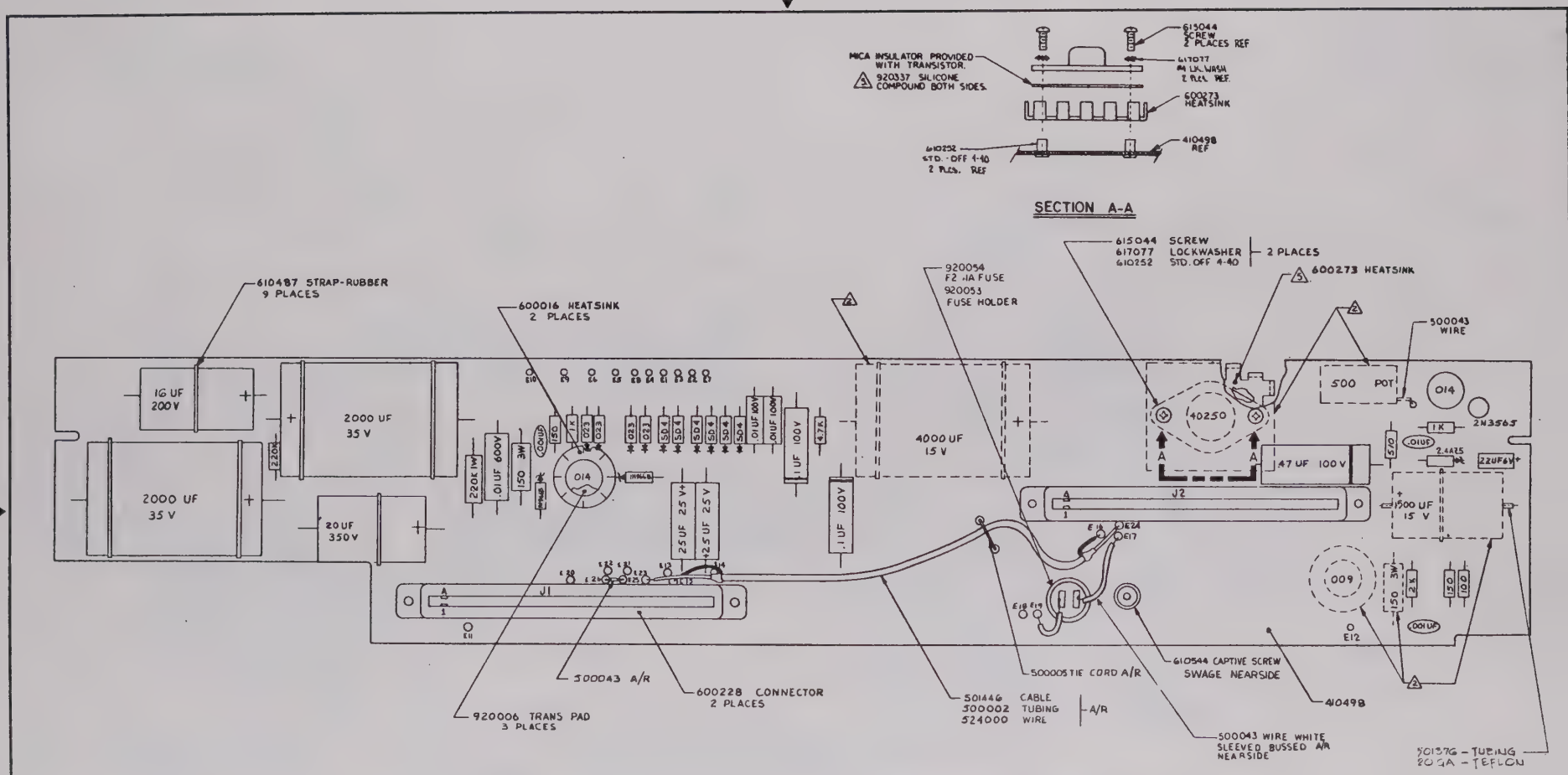
1. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM WITH DANA WORKMANSHIP STANDARDS.
2. SCHEMATIC REF NO. 430842.

DANA DANA LABORATORIES INC. IRVINE, CALIFORNIA

ASSY- POWER SUPPLY FULL RACK

SIZE	CODE IDENT NO	DWG NO.	REV
D	21793	403208	M

SCALE 1/1 SHEET OF



△5 PUT SILICONE COMPOUND ON BOTH SIDES OF THE MICA INSULATOR PROVIDED WITH THE 40250 PWR TRANSISTOR.
4 ALL RESISTORS ARE IN OHMS 1/4W, ± 5% CARBON
3 REF SCHEMATIC NO. 430842.
△2 COMPONENTS LOCATED FARSIDE.
1. ASSEMBLY PROCESSES AND PROCEDURES TO CONFORM TO DANA WORKMANSHIP STANDARDS.

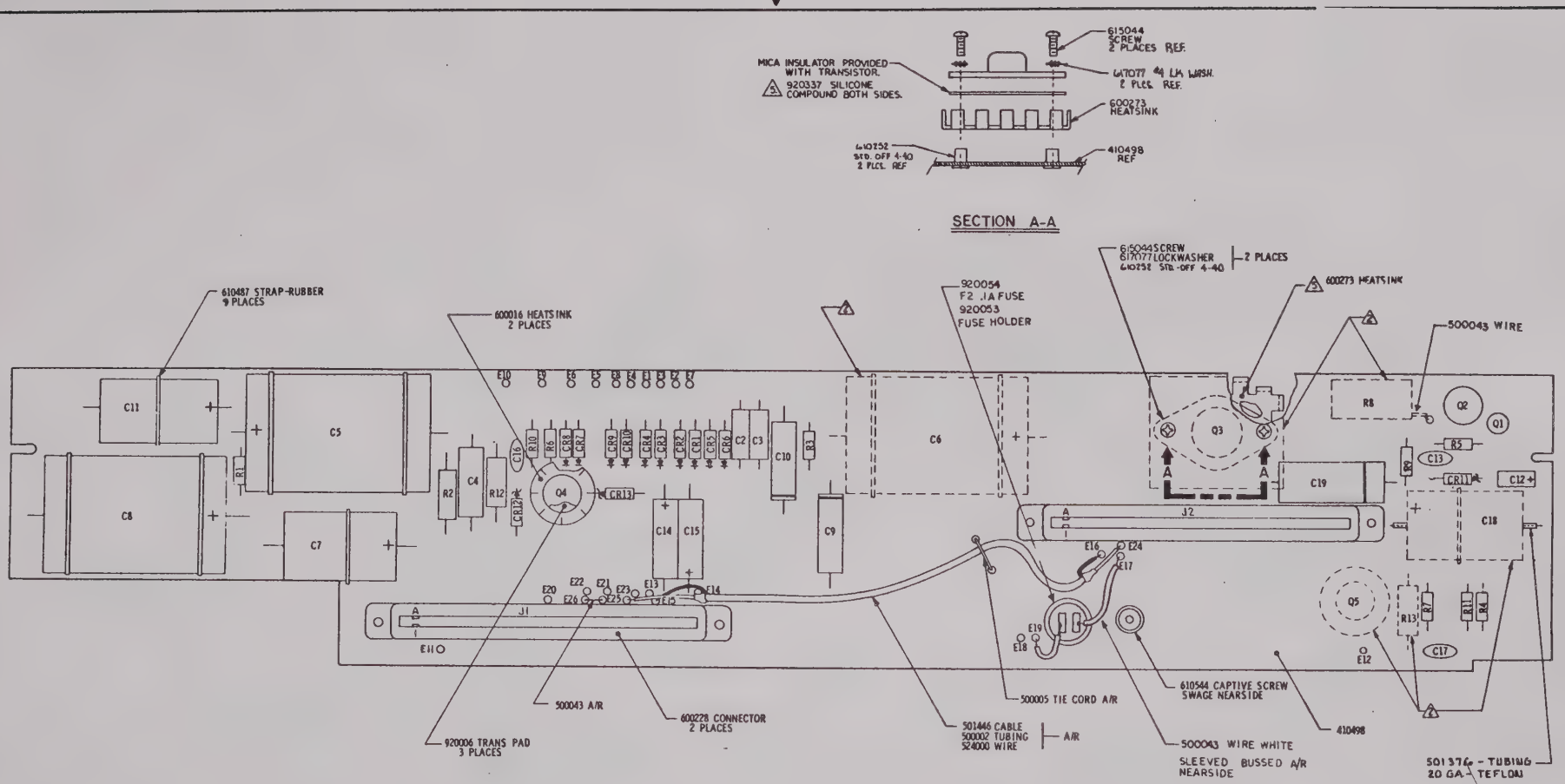
NOTES UNLESS OTHERWISE SPECIFIED

DANA DANA LABORATORIES INC. IRVINE, CALIFORNIA

P.C BOARD ASSY POWER SUPPLY FULL RACK

SIZE	CODE IDENT NO	DWG NO	REV
D	21793	403081	M

SCALE 2/1 SHEET 1 OF 3



5 PUT SILICONE COMPOUND 920337 ON BOTH SIDES OF THE MICA INSULATOR PROVIDED WITH THE 40250 PWR TRANSISTOR.

4. ALL RESISTORS ARE IN OHMS 1/4W, ±5% CARBON.
3. REF SCHEMATIC NO. 430842.
2. COMPONENTS LOCATED FARSIDE.
1. ASSEMBLY PROCESSES AND PROCEDURES TO CONFORM TO DANA WORKMANSHIP STANDARDS.

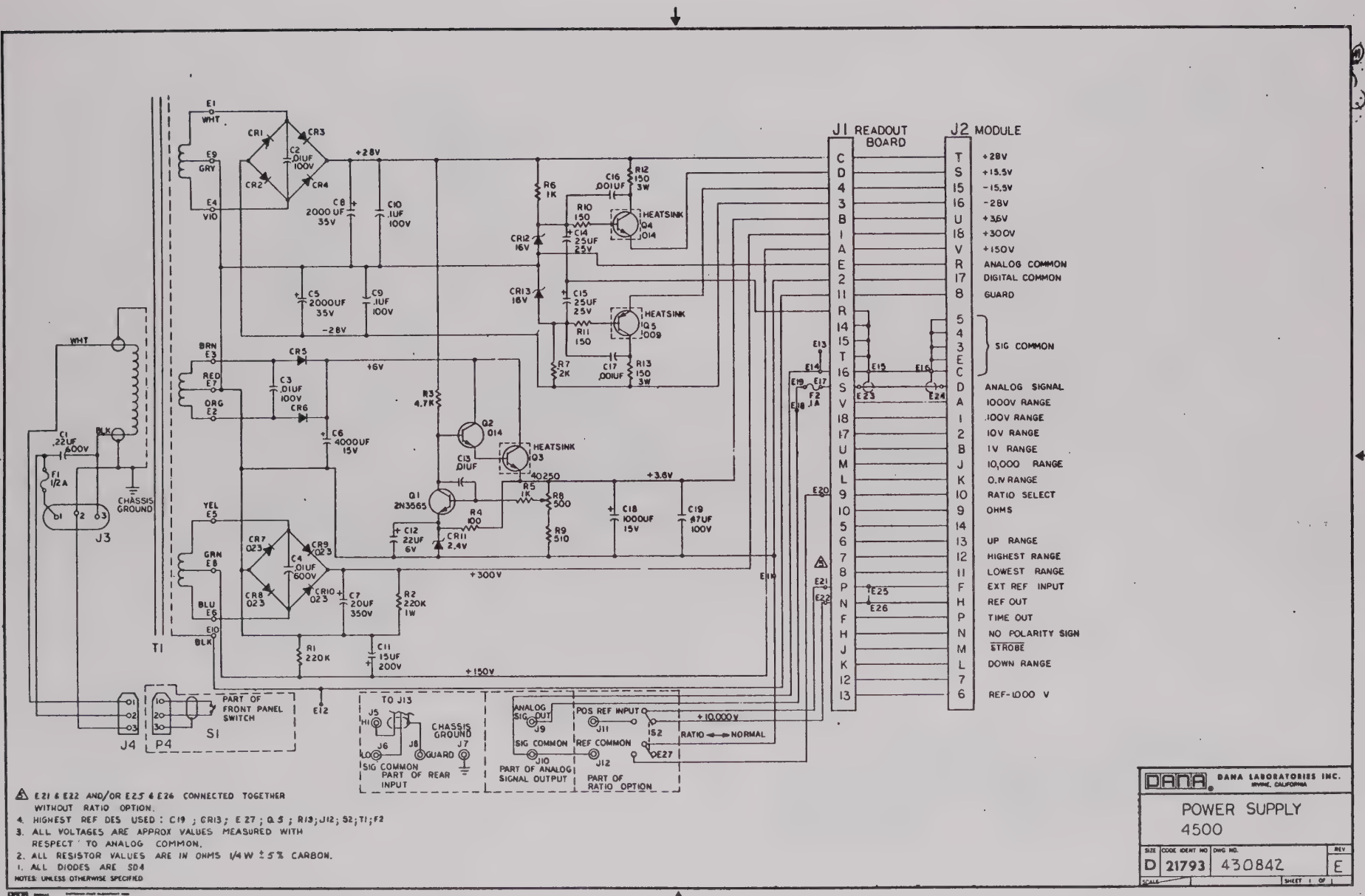
NOTES UNLESS OTHERWISE SPECIFIED

DANA DANA LABORATORIES INC. IRVINE, CALIFORNIA

PC BOARD ASSY POWER SUPPLY FULL RACK

SIZE	CODE IDENT NO	DWG NO	REV
D	21793	403081	M

SCALE: 1/1 SHEET 2 OF



⚠ E21 & E22 AND/OR E23 & E26 CONNECTED TOGETHER WITHOUT RATIO OPTION.

4. HIGHEST REF DES USED : C19 ; CR13 ; E 27 ; Q 3 ; R13 ; J12 ; S2 ; T1 ; F2
3. ALL VOLTAGES ARE APPROX VALUES MEASURED WITH RESPECT TO ANALOG COMMON.
2. ALL RESISTOR VALUES ARE IN OHMS 1/4 W ± 5% CARBON.
1. ALL DIODES ARE SD4

NOTES: UNLESS OTHERWISE SPECIFIED

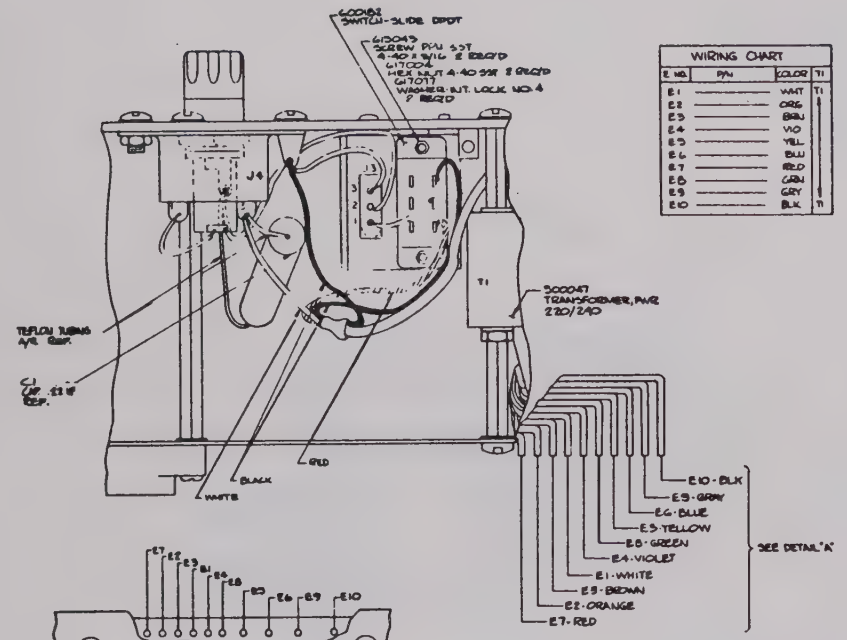
DANA DANA LABORATORIES INC. IRVINE, CALIFORNIA

POWER SUPPLY
4500

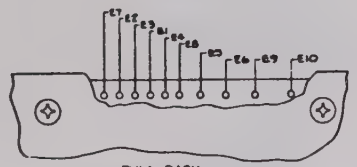
SIZE	CODE IDENT NO	DWG NO.	REV
D	21793	430842	E

SCALE | SHEET 1 OF 1

REVISIONS			
LTR	DESCRIPTION	DR	CHK
A	RELEASED PER DRN # 905 8-7-9		
B	ADD WIRING DETAIL ED 9577		

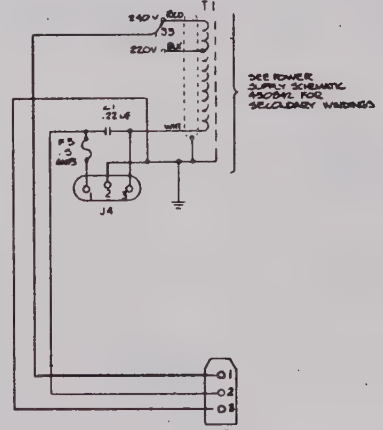


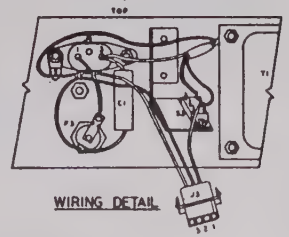
WIRING CHART			
E NO.	P/N	COLOR	T1
E1		WHT	T1
E2		ORG	
E3		BRN	
E4		VIO	
E5		YEL	
E6		BLU	
E7		RED	
E8		GRN	
E9		GRY	
E10		BLK	T1



FULL RACK
POWER SUPPLY VIEWED FROM REAR

DETAIL "A"





WIRING DETAIL

FULL RACK MODIFICATION

403284	5270	1	1
403288	5230	1	1
403289	4570	1	1
403206	4530	1	1
NEXT ASSY	USED ON		
APPLICATION			QTY REQD

1 ASSY PROCESSED AND PROCEDURES TO CONFORM TO DANA WORKMANSHIP STANDARDS.

NOTES: UNLESS OTHERWISE SPECIFIED

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES

DECIMALS X .030 XX .015 XXX .010 | ANGLES 0° 30' FORMED 1° 0' | HOLE DIAMETERS ± .004 ± .001

DIMENSIONS AND TOLERANCES PER USAS Y14.5M

MATERIAL | FINISH

DRAWN M.J. Gutierrez 7/14/69
CHECK [illegible] 7/20/69
ENGR [illegible] 7/21/69
PROJ ENGR
PROD ENGR
PROJ MGR W.S. 7-30-69
QUAL [illegible] 7-31-69

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

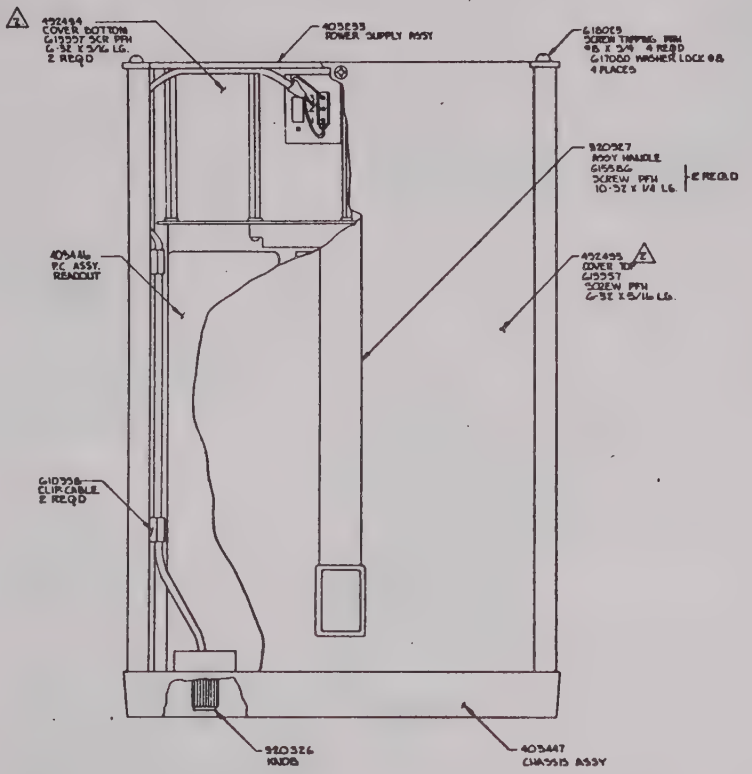
ASSY POWER SUPPLY
MODI 220/240V

SIZE D | CODE IDENT NO 21793 | DWG NO 403269 | REV B

SCALE | SHT 1 OF 2

3T3 as A adds

REVISIONS				
LTR	DESCRIPTION	DR	CHK	APP'D
A	RELEASED PER DRN # 977			



TOP VIEW

⚠ FINISH KIT REF #403234

1. ASSEMBLE PROCEDURES AND PROCESSES TO CONFORM WITH DANA WORKMANSHIP STANDARDS.

NOTES: UNLESS OTHERWISE SPECIFIED

	5370			
NEXT ASSY	USED ON			
APPLICATION		QTY REQ'D		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES

DECIMALS	ANGLES	HOLE DIAMETERS
X.XXX ±.010	± 30' FRACTIONS ± 1/64	+.004 -.000
XX.XXX ±.005		
XXX.XXX ±.002		

DIMENSIONS AND TOLERANCES PER ANSI Y14.5

MATERIAL | FINISH

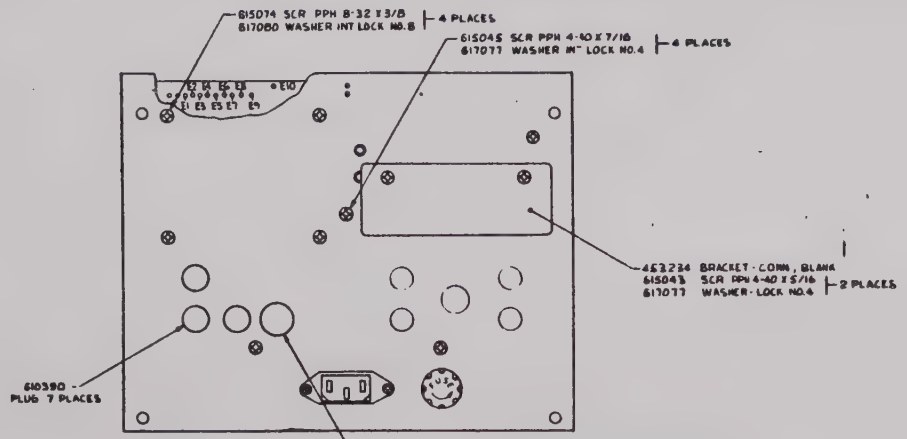
DRAWN	Wm. M. Henry	1-15-70
CHECKED		
ENGR APPV'D		
MFG APPV'D		
PROJ MGR		
QUALITY		

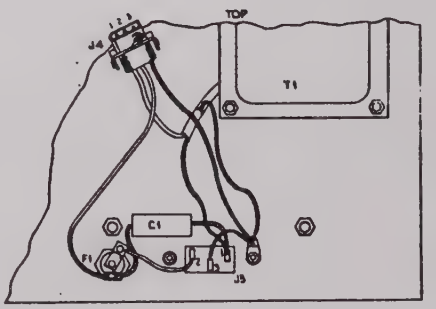
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

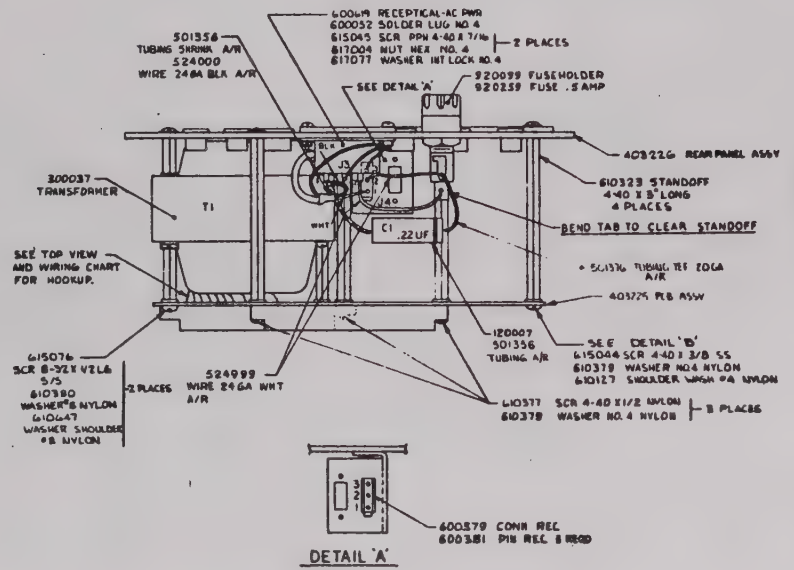
ASSY – DVM 5370
HALF RACK

SIZE	DRAWING NO.	REV. NO.	REV
D	21793	400965	A

SCALE: DRAWN TO A 4" SQUARE / NONE

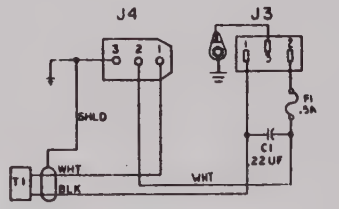

615074 SCR PPH 8-32 X 3/8
617080 WASHER INT LOCK NO.8
4 PLACES
615045 SCR PPH 4-40 X 7/16
617077 WASHER INT LOCK NO.4
4 PLACES
453234 BRACKET-CONN, BLANK
615043 SCR PPH 4-40 X 5/16
617077 WASHER-LOCK NO.4
2 PLACES
610390 PLUG 7 PLACES
610548 PLUG 2 PLACES



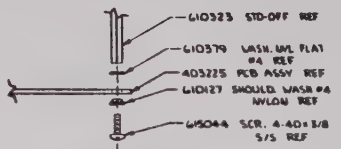


DETAIL 'A'
TOP VIEW

WIRING CHART			
C NO	P.N.	COLOR	T1
E1		WHT	T1
E2		ORG	
E3		GRN	
E4		VIO	
E5		YEL	
E6		BLU	
E7		RED	
E8		BRN	
E9		GRY	
E10		BLK	T1



WIRING DETAIL



DETAIL 'B'

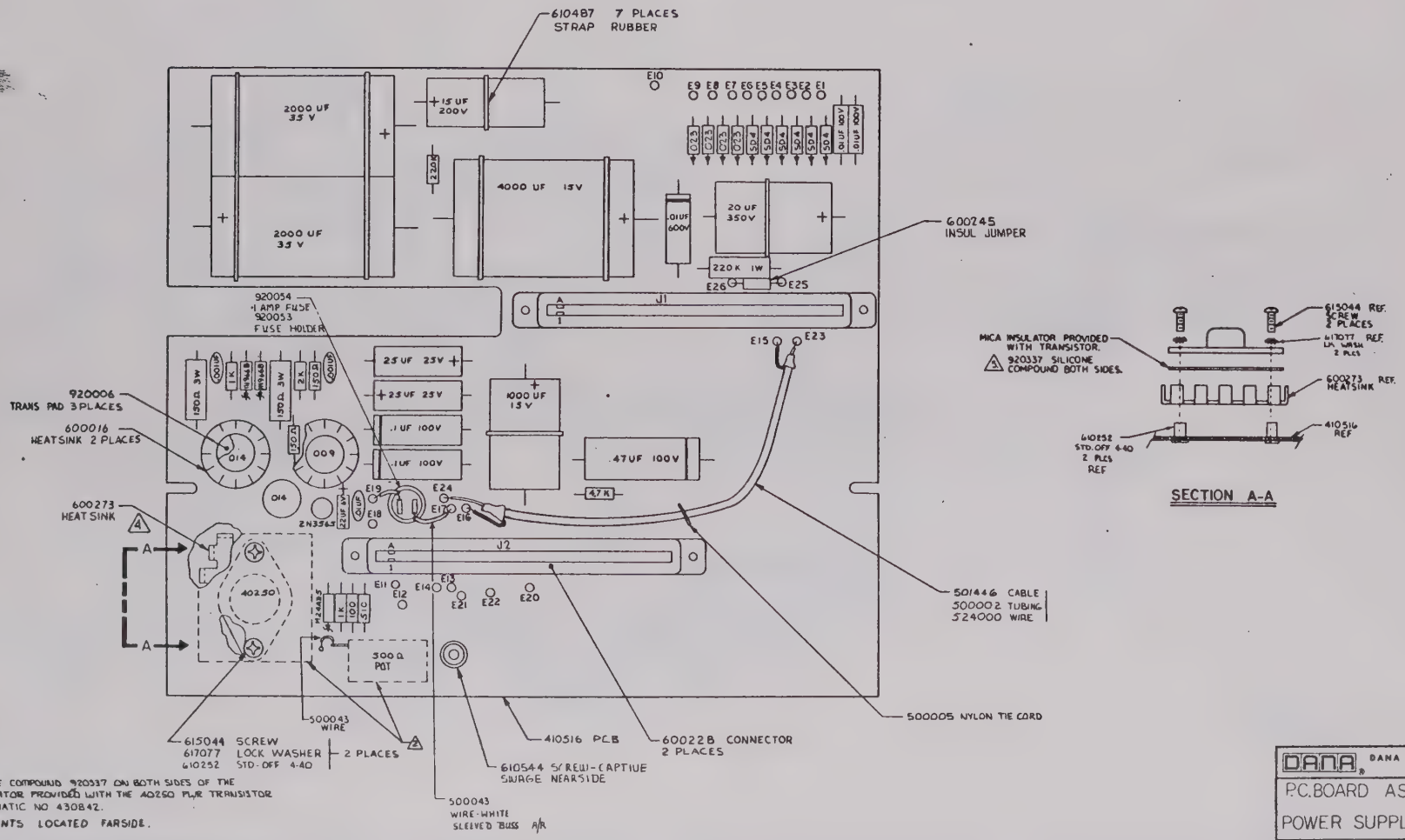
2 SCHEMATIC REF 430842
1. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM WITH DANA WORKMANSHIP STANDARDS.
NOTES: UNLESS OTHERWISE SPECIFIED

DANA DANA LABORATORIES INC. IRVINE, CALIFORNIA

POWER SUPPLY ASSY
HALF RACK

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	403233	L
SCALE 1/1		SHEET 1 OF 3	

SHT 2 AND 3 IN A SIZE



3 PUT SILICONE COMPOUND 920337 ON BOTH SIDES OF THE MICA INSULATOR PROVIDED WITH THE 402.50 PWR TRANSISTOR

3 REF SCHEMATIC NO 430842.

4 COMPONENTS LOCATED FARSIDE.

1 ASSEMBLY PROCESSES AND PROCEDURES TO CONFORM TO DANA WORKMANSHIP STANDARDS.

NOTES UNLESS OTHERWISE SPECIFIED

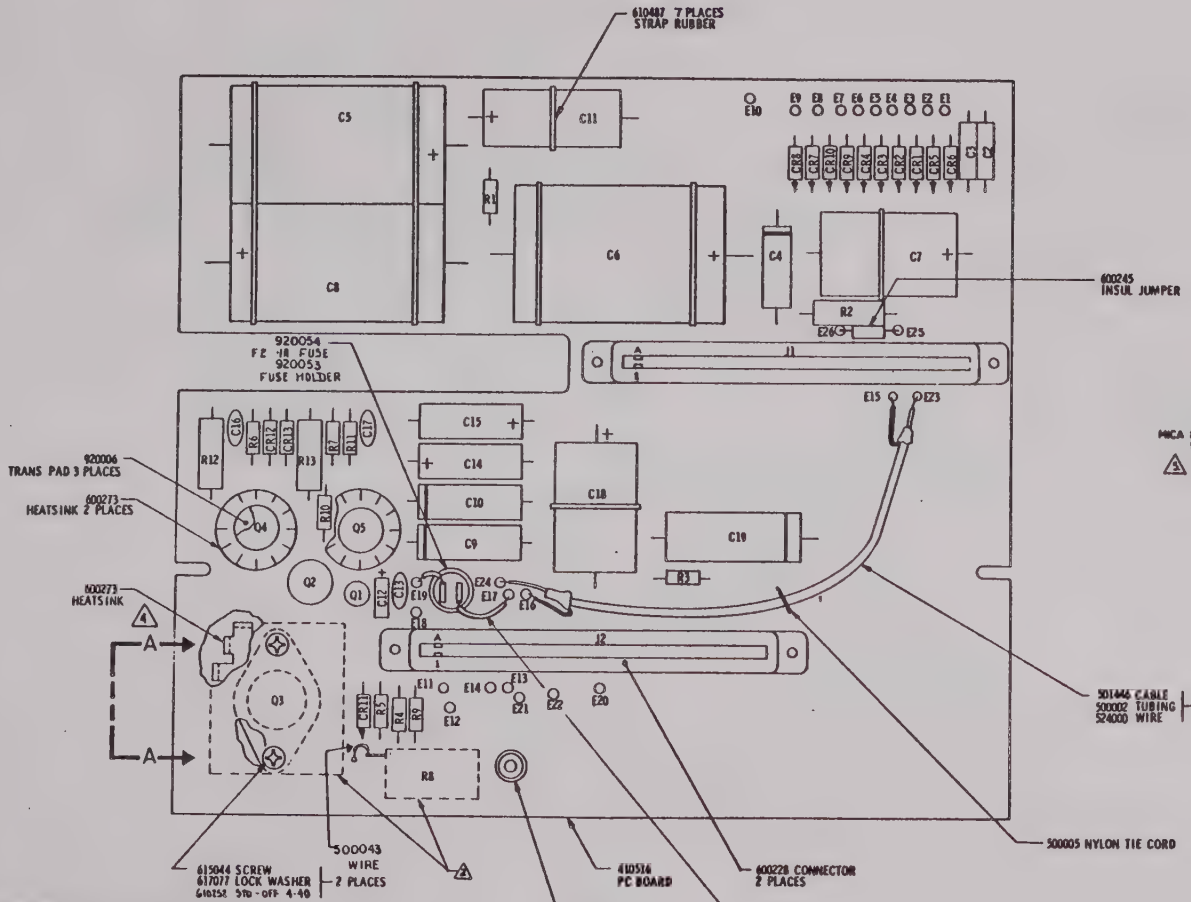
DANA DANA LABORATORIES INC. IRVINE, CALIFORNIA

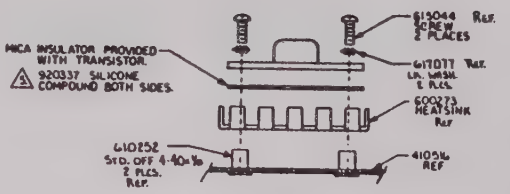
P.C. BOARD ASSY -

POWER SUPPLY, HALF RACK

SIZE	CODE IDENT NO	DWG NO	REV
D	21793	403275	H

SCALE 2/1 SHEET 1 OF 3





SECTION A-A

⚠4 PUT SILICONE COMPOUND 920337 ON BOTH SIDES OF THE MICA INSULATOR PROVIDED WITH THE 40250 PWR TRANSISTOR.

3. REF SCHEMATIC NO. 430842.

⚠2 COMPONENTS LOCATED FARSIDE.

1. ASSEMBLY PROCESSES AND PROCEDURES TO CONFORM TO DANA WORKMANSHIP STANDARDS.

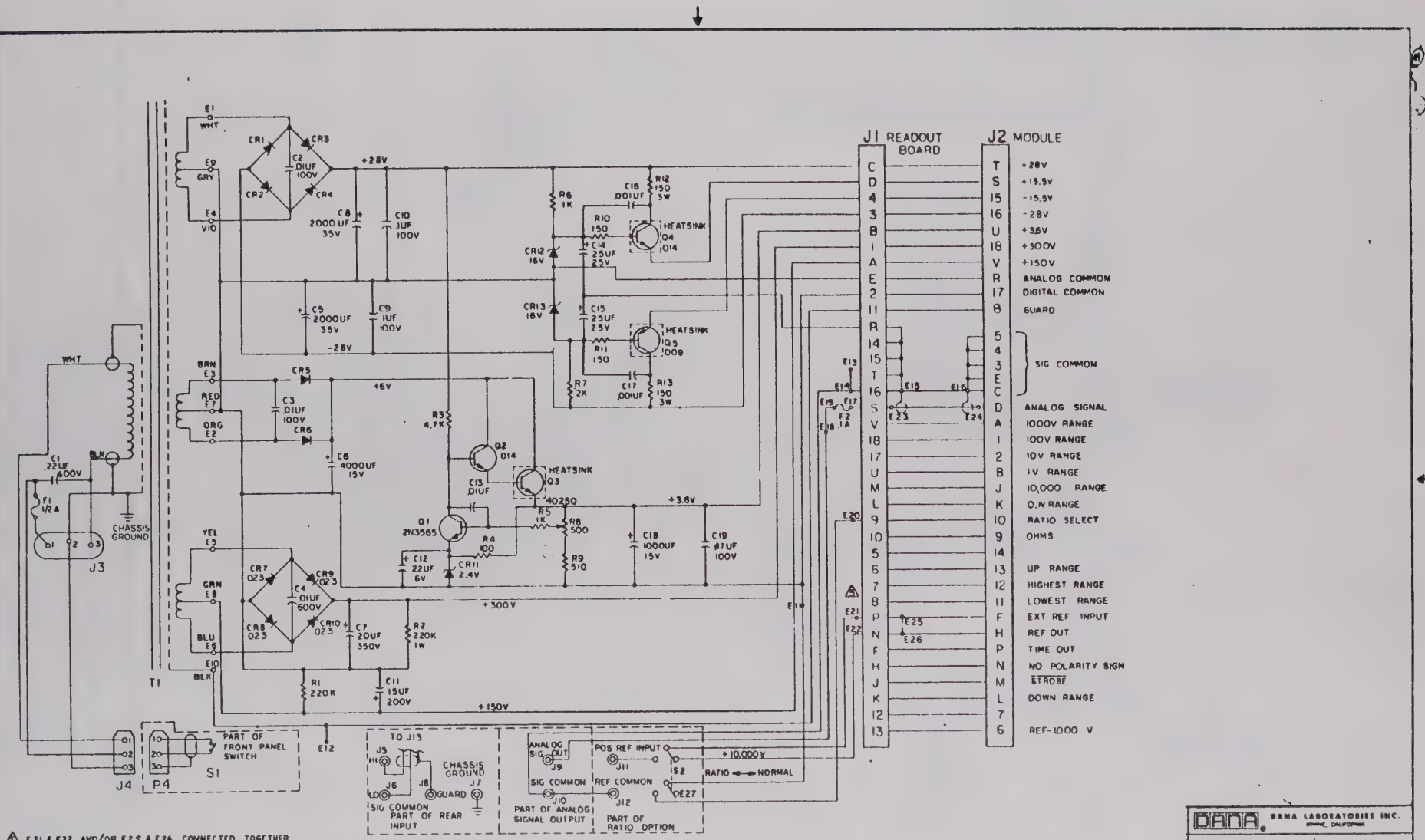
NOTES UNLESS OTHERWISE SPECIFIED

DANA DANA LABORATORIES INC. IRVINE, CALIFORNIA

P.C. BOARD ASSY -
POWER SUPPLY, HALF RACK

SIZE	COOL IDENT NO	DWG NO	REV.
D	21793	403225	H

SCALE 1/1 SHEET 2 OF 5



⚠ E21 & E22 AND/OR E25 & E26 CONNECTED TOGETHER WITHOUT RATIO OPTION.

4. HIGHEST REF DES USED : C19 ; CR13; E 27 ; Q 5 ; R13; J12; S2; T1; F2
3. ALL VOLTAGES ARE APPROX VALUES MEASURED WITH RESPECT TO ANALOG COMMON.
2. ALL RESISTOR VALUES ARE IN OHMS 1/4W ±5% CARBON.
1. ALL DIODES ARE SD4

NOTES: UNLESS OTHERWISE SPECIFIED

DANA LABORATORIES INC. IRVINE, CALIFORNIA

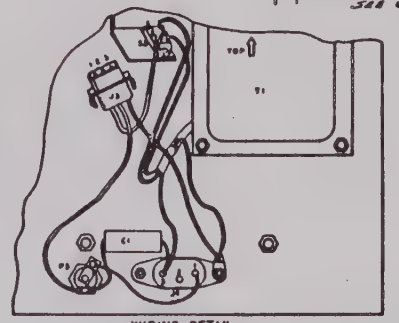
POWER SUPPLY
4500

SIZE	CODE IDENT NO	DWG NO	REV
D	21793	430842	E

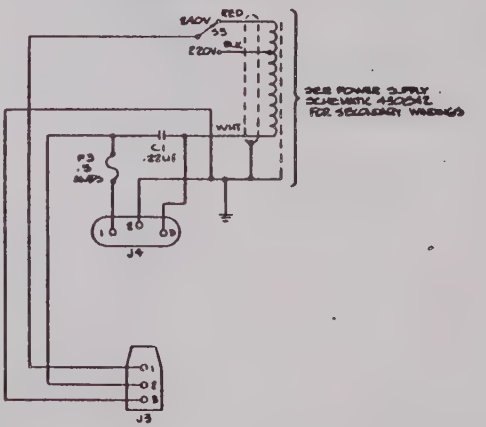
SCALE — SHEET 1 OF 1

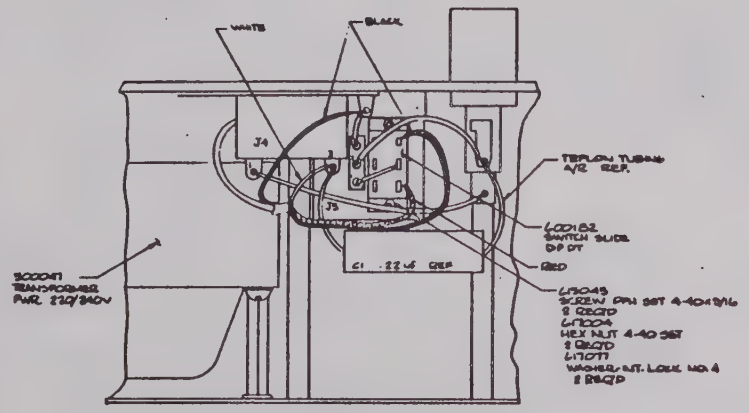
REVISIONS				
LTR	DESCRIPTION	DR	CHK	APPD
	RELEASED PER DRN # SEE SHEET 1			

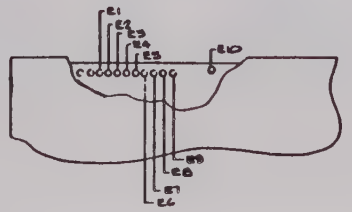
WIRING CHART		
E NO.	COLOR	T1
E1	WHT	
E2	ORG	
E3	BRN	
E4	WHT	
E5	YEL	
E6	BLU	
E7	RED	
E8	GRN	
E9	GRY	
E10	BLK	T1



WIRING DETAIL

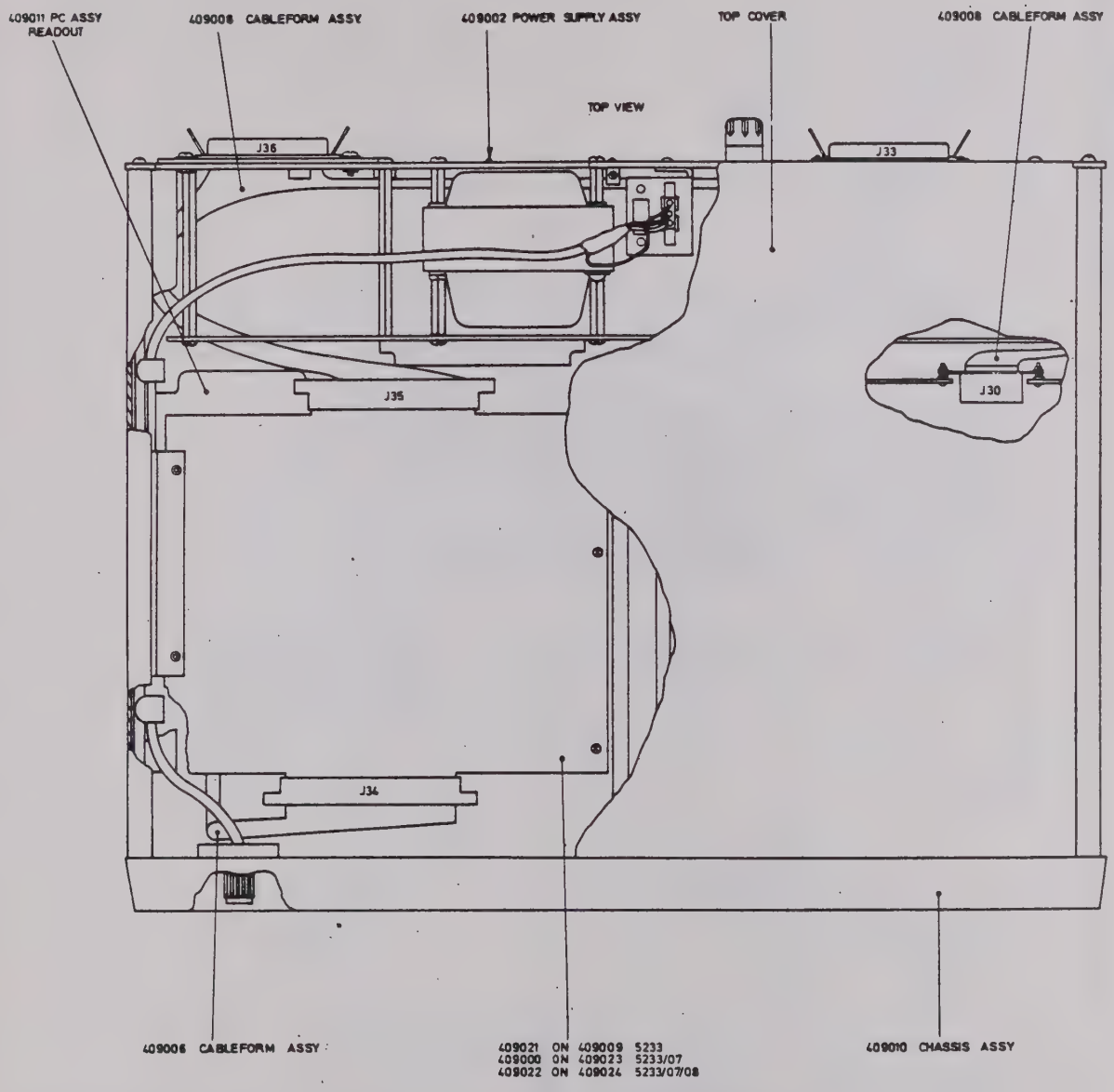




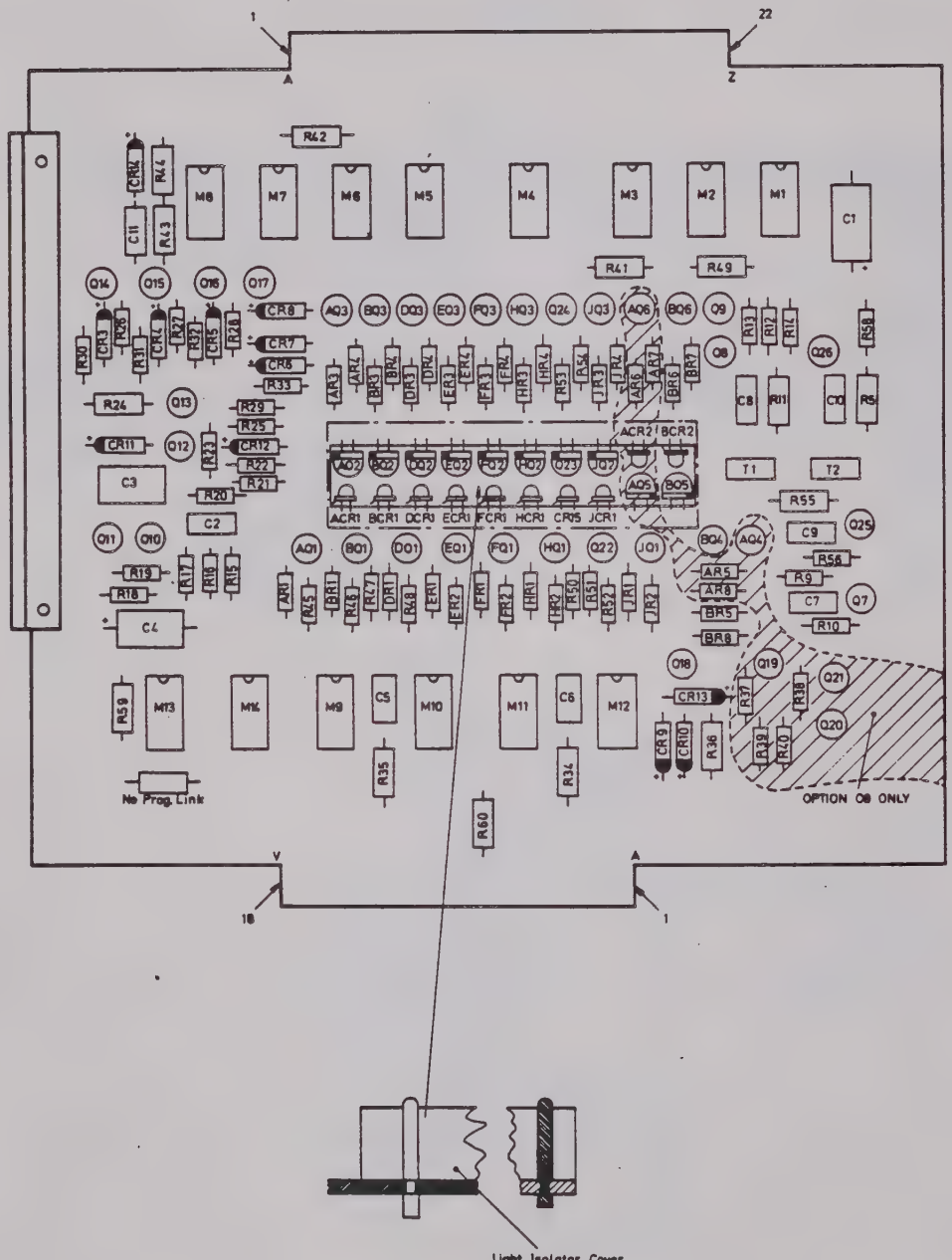


HALF RACK POWER SUPPLY VIEWED FROM REAR

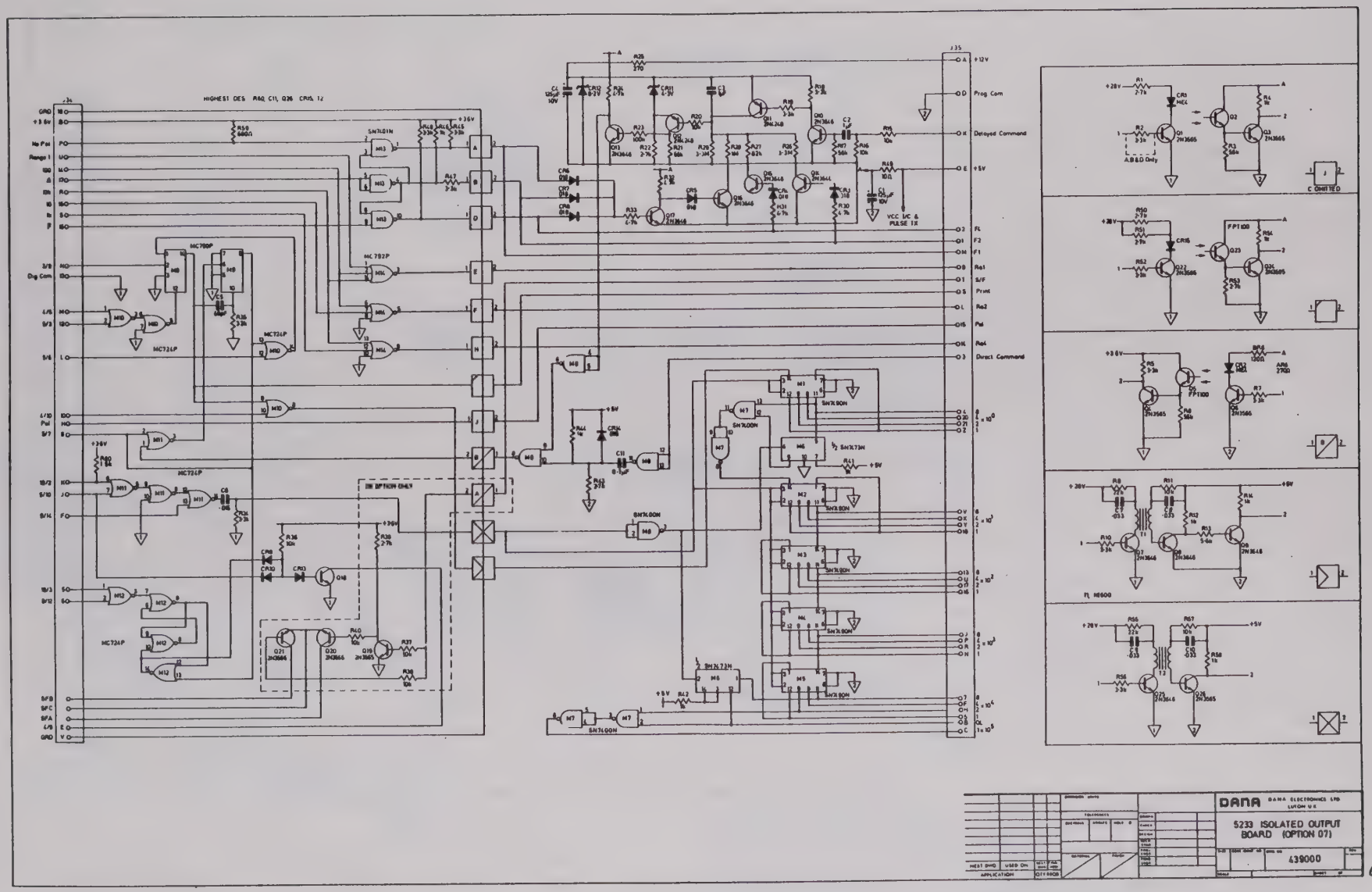
HALF RACK MODIFICATION

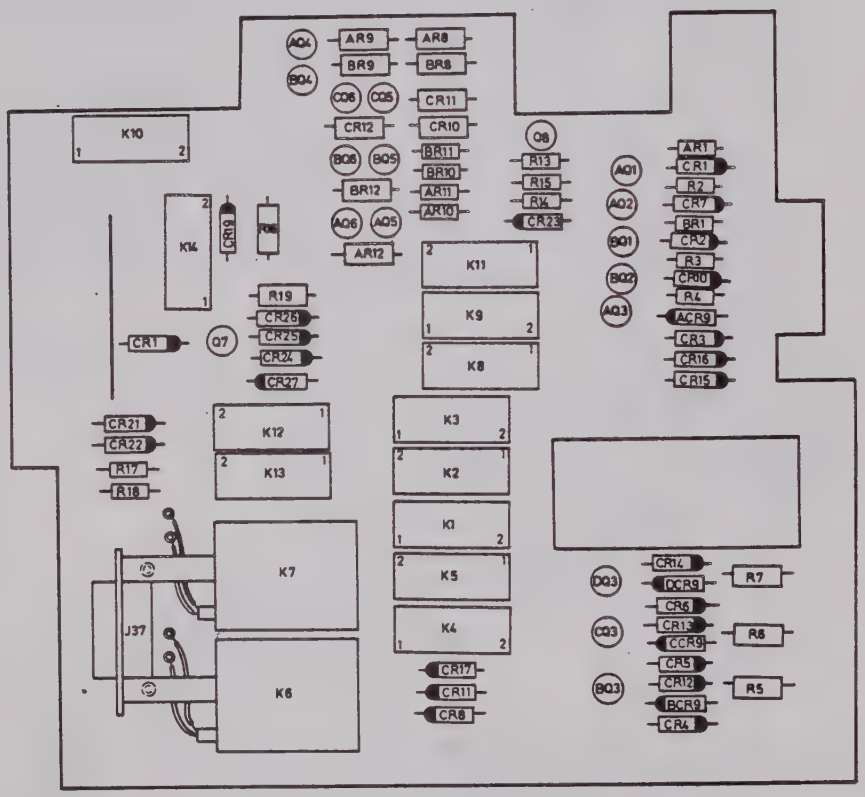


Assembly Procedure and Processes to conform with DANA workmanship standards.
Unless otherwise specified.

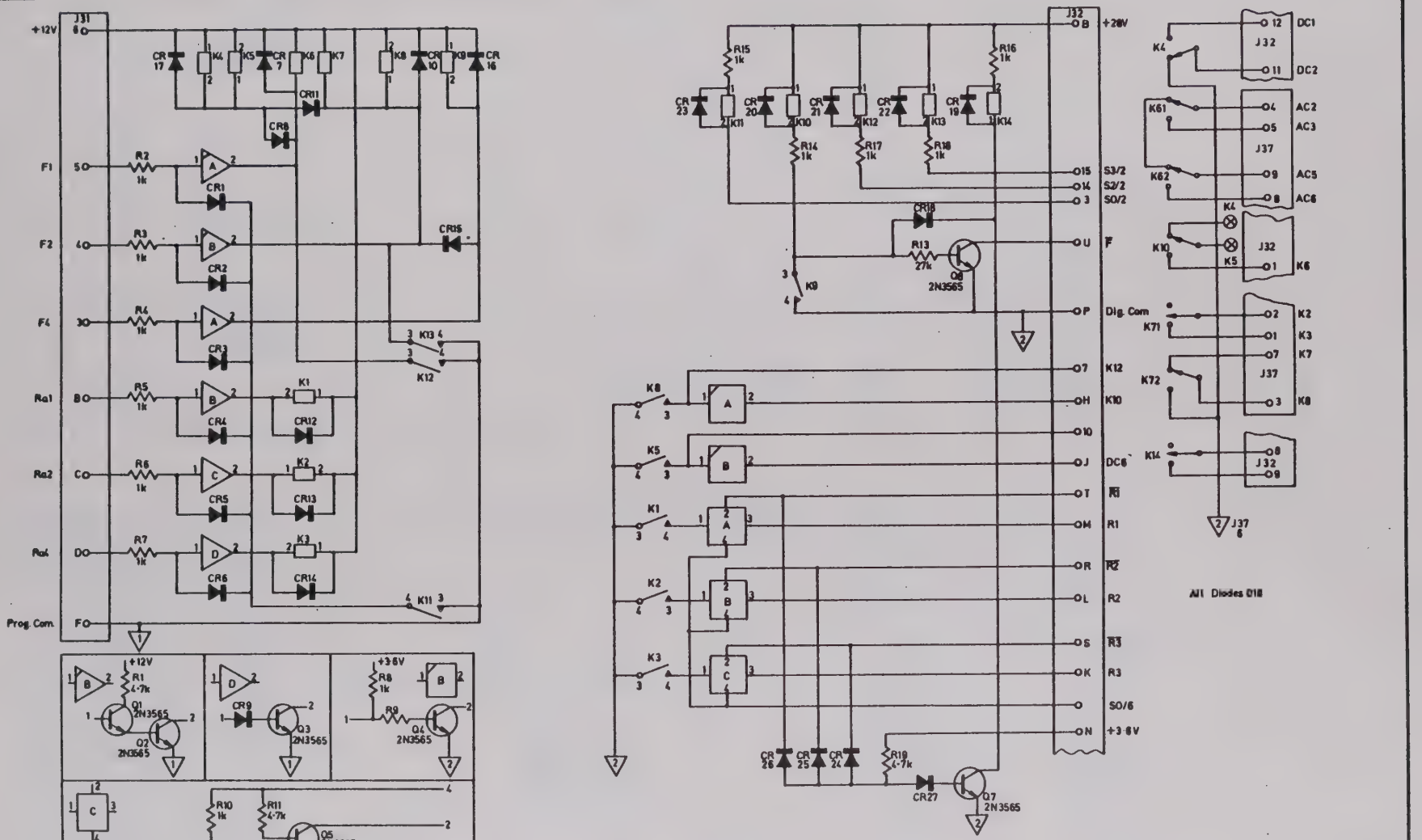


NEXT DWG.	USED ON	NEXT ASSY.				DANA	DANA ELECTRONICS LTD. LUTON U.K.
APPLICATION		QTY. REQD.				5233/07 ISOLATED OUTPUT BOARD	
						SIZE A	DWG. NO. 409000


DANA
DANA ELECTRONICS LTD
LUTON U.K.
5233 ISOLATED OUTPUT
BOARD (OPTION 07)
439000


AQ4
AR9
AR8
BR9
BR8
BQ4
CQ6
CQ5
CR11
CR12
CR10
BQ6
BQ5
BR11
BR10
BR12
AR11
AR10
AQ6
AQ5
AR12
Q8
R13
R15
R14
CR23
AQ1
AQ2
BQ1
BQ2
AQ3
AR1
CR1
R2
CR7
BR1
CR2
R3
CR20
R4
ACR9
CR3
CR16
CR15
K10
K14
CR19
K11
K9
K8
R19
CR26
CR25
CR24
CR27
CR1
Q7
CR21
CR22
R17
R18
K12
K13
K3
K2
K1
K5
K4
K7
K6
J37
CR17
CR11
CR8
DQ3
CQ3
BQ3
CR14
DCR9
CR6
CR13
CCR9
CR5
CR12
BCR9
CR4
R7
R8
R5

| | | |


J31
+12V
F1
F2
F4
Rs1
Rs2
Rs4
Prog. Com.
J32
+28V
S3/2
S2/2
SO/2
Dig. Com
+3·6V
SO/6
DC1
DC2
AC2
AC3
AC5
AC6
DC6
All Diodes 018
SCHEMATIC PROGRAM 553
DANA ELECTRONICS LTD.
LUTON U.K.
439001

SECTION 7
BCD OUTPUT OPTION (5233/07)

7.1 GENERAL DESCRIPTION

7.2 The Dana Model 5233/07 is a model 5230 DMM with isolated output capability. Isolated output codes are provided for function and range and isolated BCD output for numeric display. External control and response signals are also isolated from the DMM measuring circuitry.

7.3 The 5233/07 produces 1248 positive true TTL logic voltage levels to a 50-pin connector at the rear panel of the instrument.

7.4 The output circuitry is located on printed board 409000 and is shown in schematic 439000. The board is mounted directly above the readout section of the DMM. Display data is generated by a slave TTL counter coupled to the DMM measuring circuits by pulse transformers. All other input-output data is fed to and from the DMM measuring circuits via light isolators. Voltages for the output option are generated by an internal power supply, also isolated from the DMM measuring circuits.

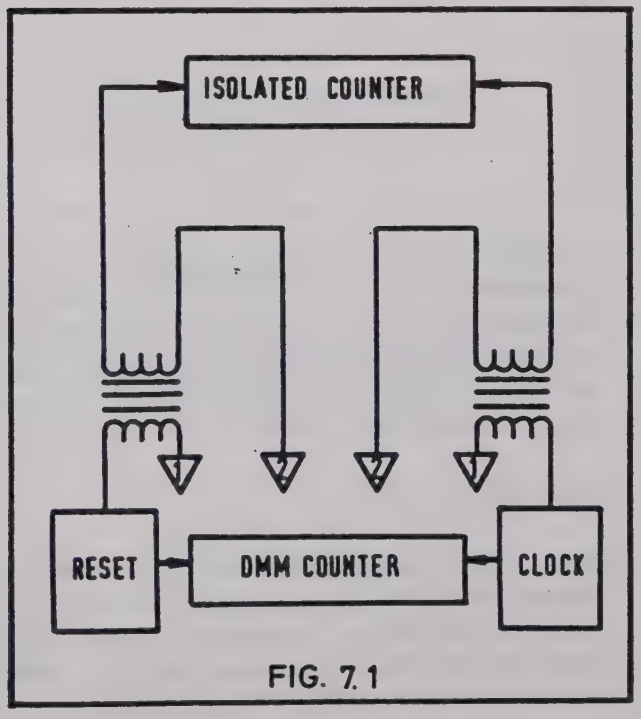


FIG. 7.1

7.5 Counter clock pulses from the DMM are fed via a pulse transformer to a TTL counter located on the output side of the isolated output circuit board. This counter thus acts as a slave to that in the standard DMM and is reset by pulse transformer coupled reset pulses (see fig.7.1.)

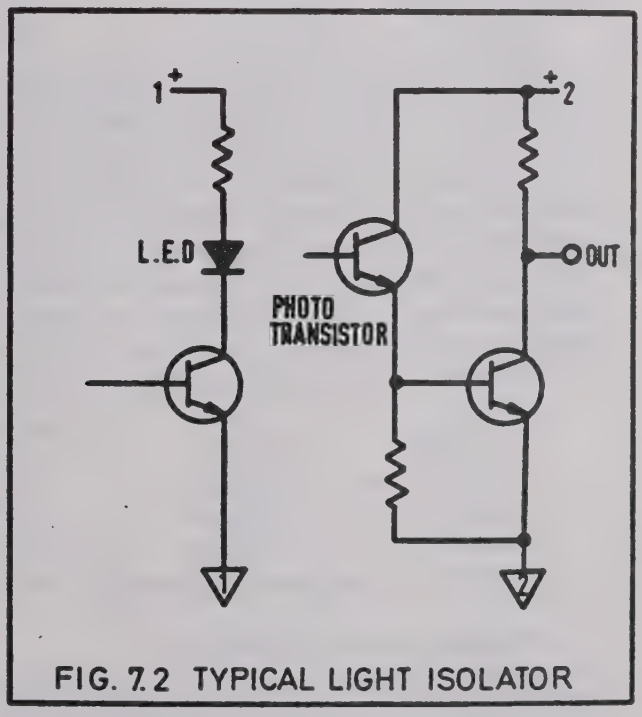


FIG. 7.2 TYPICAL LIGHT ISOLATOR

Range, function and print command levels are transferred from the basic DMM to the output by light-emitting diode and photo transistor pairs, the coupling signal therefore being transferred by a light path only. Read command signals are transferred with the DMM by the same technique (see fig.7.2).

7.6 OPERATION

7.7 The function and range are selected either remotely via the 553 programming module or the push button front panel selectors (Auto-range cannot be used if remote selection of function is still required). With the front panel off/on/hold switch set to ON the DMM will take about four readings per second and the BCD data will remain held until each new reading commences. With the off/on/hold switch set to HOLD the DMM may be commanded to read via the rear panel connector and data from a particular reading will be held until another command is given or the front panel switch returned to ON.

7.8 EXTERNAL COMMAND

By placing the DMM in the hold mode it can be commanded to take a reading, i.e. commence digitising when :

(a) A direct command is given.

A direct command is achieved by placing a TTL logic '1' on pin 23 of either rear panel connector J36 or J33. A logic '1' is greater than 2.0 volts and less than 5.5 volts. Minimum pulse duration is 100 micro-seconds. Upon receipt of the direct command the DMM will immediately commence digitising. This means that the signal information must have been presented to the DMM input terminals for certain times previous to the direct command signal. These times depend on functions as follows :

D.C. Fast	50 ms
D.C. Filtered	500 ms
A.C.	2 seconds
OHMS	1 second
OHMS 10 Meg. ohm	10 seconds

(b) A delayed command is given.

Delayed command is achieved in the same way as direct command but on pin 22 of either rear panel connector, however the DMM does not start digitising immediately. The DMM commences digitising after delays depending on functions as in the table in paragraph (a). (There is only a one second built-in delay for the 10 Meg.ohm range, though.) This means that the input signal can be applied to the DMM at the same instant as the delayed command and the built-in delays will allow for worst case settling time of the appropriate analogue circuitry. If using delayed command on the 10 Meg.ohm range an additional delay of 9 seconds should be allowed.

7.9 PRINT COMMAND OUTPUT

7.10 The print command is a TTL logic pulse appearing on pin 48 of rear panel 50-way connector J.36. The voltage on pin 48 rises to a logic '1' level at the completion of the signal integrate period and falls to a logic '0' at the completion of the read cycle. As the print command rises to a logic '1'

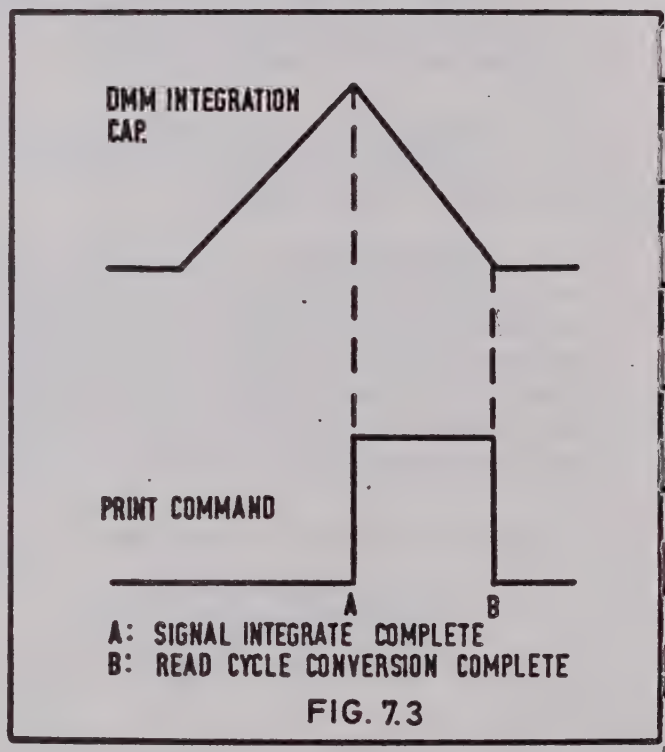


FIG. 7.3

therefore, new data may be applied to the DMM measuring circuits and as the print command falls to zero, conversion is complete and the BCD output at the rear connector J36 may be read by computer or printer. This may be interpreted as 'Information Not Available' during '1' state. (See fig. 7.3.)

7.11 BCD CODING

7.12 BCD coding of the DMM digital output is positive true 1248 code compatible with TTL logic inputs. In the table, '1's represent true or greater than 2.4 volts (less than 5 volts) and '0's represent less than 0.5 volts (greater than zero volts).

07 DIGITAL OUTPUT LOGIC TABLE

BCD CODE	1	2	4	8	DECIMAL VALUE
Data:					
1	1	0	0	0	1
2	0	1	0	0	2
3	1	1	0	0	3
4	0	0	1	0	4
5	1	0	1	0	5
6	0	1	1	0	6
7	1	1	1	0	7
8	0	0	0	1	8
9	1	0	0	1	9
0	0	0	0	0	0
Range:					
1	1	0	0	0	1
10	0	1	0	0	2
100	1	1	0	0	3
1000	0	0	1	0	4
10000	1	0	1	0	5
Polarity:					
+	0	0	0	0	0
–	1	0	0	0	1
Function:					
DC	0	0	0	0	0
DC Fast	0	0	1	0	4
AC	1	0	0	0	1
Ohms	0	1	0	0	2

07 DIGITAL OUTPUT PIN ASSIGNMENTS

Output Connector (J36): 50-pin Amphenol Blue Ribbon

Mating Connector: Amphenol 57-30500

	BCD WEIGHT	PIN NO.		BCD WEIGHT	
Range	1	1	26	4	Range
Range	2	2	27	8	Range
Polarity	1	3	28	4	Polarity
Polarity	2	4	29	8	Polarity
Units	1	5	30	4	Units
Units	2	6	31	8	Units
10's	1	7	32	4	10's
10's	2	8	33	8	10's
100's	1	9	34	4	100's
100's	2	10	35	8	100's
1000's	1	11	36	4	1000's
1000's	2	12	37	8	1000's
10,000's	1	13	38	4	10,000's
10,000's	2	14	39	8	10,000's
100,000's	1	15	40	4	100,000's
100,000's	2	16	41	8	100,000's
Function	1	17	42	4	Function
Function	2	18	43	8	Function
		19	44		
		20	45		
Overload		21	46		
Delayed Command		22	47		
Direct Command		23	48		Print Command
Common		24	49		Super-Fast
		25	50		5 Volt Reference

7.13 PIN ASSIGNMENTS

7.14 The location for the BCD outputs is shown together with control pin assignments.

SECTION 8
SUPERFAST OPTION (5233/07/08)

8.1 GENERAL

8.2 The Dana 08 superfast option is additional circuitry fitted to the 5233/07 to permit high speed D.C. voltage measurements.

8.3 On being commanded via one of the rear panel 50 way connectors (pin 49) with a logic '1' the DMM will take up to 100 readings per second. This is accomplished by by-passing two decades of the main DMM counter so measurements are converted using only 1% of the normal integrator full scale ramp. Accuracy is thus reduced by an order of nearly 100 and speed increased by an order of nearly 100. (In fact speed is not increased this much due to certain fixed recovery times within the DMM.) Under superfast operation two of the front panel display nixies (2nd and 3rd decades) portray random numbers and the BCD output is shifted down range by two decades with respect to the range information. That is, an apparent output of 0.01000 volts is, in superfast, 1·000 volts.

8.4 SPECIFICATIONS IN SUPERFAST

8.5 Specifications in superfast are identical to the normal 5233 with the following exception :

Accuracy: $\pm$0.2% of reading $\pm$0.2% of Fullscale.

Superfast is normally used with the filter switched out and is too fast for line integration. Normal mode rejection is therefore reduced to zero for low frequency noise (below 1 kHz).

SECTION 9
553 REMOTELY PROGRAMABLE MULTIMETER MODULE

9.1 GENERAL

9.2 The Dana accessory module 553 in a standard 550 module with electrically isolated remote programming capability.

9.3 OPERATION

9.4 For remote operation select REMOTE and AUTO/REMOTE on module front panel. This enables remote programming of range and function, via rear panel 50-way connector J.33. Codes and pin assignments are given below. '1's and '0's are TTL levels.

PROGRAMMING LOGIC TABLE AND PIN ASSIGNMENTS

Remote Program Connector (J33): 50-pin Amphenol Blue Ribbon Mating Connector: Amphenol 57-30500				
BCD CODE:		1	2	4
RANGE:	Pin No.	1	2	26
1		1	0	0
10		0	1	0
100		1	1	0
1000		0	0	1
10000		1	0	1
FUNCTION:	Pin No.	4	5	29
DC		0	0	0
DC Fast		0	0	1
AC		1	0	0
Ohms		0	1	0
Delayed Command:		Pin No. 22		
Direct Command:		Pin No. 23		
Common:		Pin No. 24		
5 Volt Reference:		Pin No. 50		
Super-Fast:		Pin No. 49		
Periodic Read:		Pin No. 37		

If auto range is required function must be normally selected.

9.5 MANUAL USE

9.6 When function is selected manually all program information is inhibited.

PARTS LIST

ASSEMBLY 403446 READOUT 5200

REF. DESIG.	PART NO.	DESCRIPTION					
C01	101174	CAP	CERAM	.001 MFD	500 V	10%	AEROVOX SCD3X5F
C02	101174	CAP	CERAM	.001 MFD	500 V	10%	AEROVOX SCD3X5F
C03	101646	CAP	CERAM	250 PFD		10%	AEROVOX TCDN4700
C04	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE TH-S10
C05	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE TH-S10
C06	101174	CAP	CERAM	.001 MFD	500 V	10%	AEROVOX SCD3X5F
C07	100019	CAB	CERAM	.002 MFD	10000V		SPRAGUE 5GA-D20
C08	100019	CAB	CERAM	.002 MFD	10000V		SPRAGUE 5GA-D20
C09	110001	CAP	TANTA	6.8 MFD	35 V	10%	KEMET K6R8C35K
C10	110001	CAP	TANTA	6.8 MFD	35 V	10%	KEMET K6R8C35K
C11	110032	CAP	TANTA	22 MFD	15 V	10%	KEMET K22C15K
C12	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE TH-S10
C13	101174	CAP	CERAM	.001 MFD	500 V	10%	AEROVOX SCD3X5F
C14	110043	CAP	ELECT	25 MFD	25 V	20%	DUCATI 25-25
C15	101182	CAP	CERAM	47 PFD	500 V	10%	AEROVOX TCD-N750
C16	101641	CAP	CERAM	470 PFD	500 V	10%	AEROVOX SCD1X5F
C17	101175	CAP	CERAM	220 PFD	500 V	10%	AEROVOX SCD1X5F
C18	101641	CAP	CERAM	470 PFD	500 V	10%	AEROVOX SCD1X5F
C19	101641	CAP	CERAM	470 PFD	500 V	10%	AEROVOX SCD1X5F
C20	110001	CAP	TANTA	6.8 MFD	35 V	10%	KEMET K6R8C35K
C21	110001	CAP	TANTA	6.8 MFD	35 V	10%	KEMET K6R8C35K
C22	101174	CAP	CERAM	.001 MFD	500 V	10%	AEROVOX SCD3X5F
C23	110047	CAP	ELECT	50 MFD	50 V	20%	DUCATI 50-50
C24	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE TH-S10
C25	100016	CAP	CERAM	27 PFD			AEROVOX N750
C26	100016	CAP	CERAM	27 PFD			AEROVOX N750
C27	100016	CAP	CERAM	27 PFD			AEROVOX N750
C28	100016	CAP	CERAM	27 PFD			AEROVOX N750
C29	101174	CAP	CERAM	.001 MFD	500 V	10%	AEROVOX SCD3X5F
C30	101174	CAP	CERAM	.001 MFD	500 V	10%	AEROVOX SCD3X5F
C31	120003	CAP	MYLAR	.1 MFD	100 V	10%	CDE WMF1P1
C32	100012	CAP	CERAM	33 PFD	500 V	10%	AEROVOX TCD-N750
C33	120208	CAP	POLYS	55 MFD	63 V	5%	MIAL 602
C34	121091	CAP	MYLAR	.033 MFD	100 V	10%	CDE WMF1533
C35	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE TH-S10
C36	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE TH-S10
C37	100012	CAP	CERAM	33 PFD	500 V	10%	AEROVOX TCD-N750
C38	101182	CAP	CERAM	47 PFD	500 V	10%	AEROVOX TCD-N750

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PARTS LIST

ASSEMBLY 403446 READOUT 5200

REF. DESIG.	PART NO.	DESCRIPTION		
C39	101182	CAP CERAM 47 PFD 500 V 10%	AEROVOX	TCD-N750
CR01	211083	DIODE SILICO 018	DANA	211083
CR02	211083	DIODE SILICO 018	DANA	211083
CR03	211083	DIODE SILICO 018	DANA	211083
CR04	211083	DIODE SILICO 018	DANA	211083
CR05	211083	DIODE SILICO 018	DANA	211083
CR06	211236	DIODE SILICO 007	DANA	211236
CR07	211236	DIODE SILICO 007	DANA	211236
CR08	211236	DIODE SILICO 007	DANA	211236
CR09	403294	BRIDGE ELEMENT	DANA	403294
CR10	211083	DIODE SILICO 018	DANA	211083
CR11	211083	DIODE SILICO 018	DANA	211083
CR12	220019	DIODE SILICO ZENER 1N752A	MOTOROLA	1N752A
CR13	220019	DIODE SILICO ZENER 1N752A	MOTOROLA	1N752A
CR14	211236	DIODE SILICO 007	DANA	211236
CR15	211236	DIODE SILICO 007	DANA	211236
CR16	211083	DIODE SILICO 018	DANA	211083
CR17	211083	DIODE SILICO 018	DANA	211083
CR18	221255	DIODE SILICO ZENER 1N969A	MOTOROLA	1N969A
L01	310033	CHOKE 100 MH	MILLER	9210-76
M01	230022	INTEGRATED CIRCUIT MC889P	MOTOROLA	MC889P
M02	230019	INTEGRATED CIRCUIT MC824P	MOTOROLA	MC824P
M03	230019	INTEGRATED CIRCUIT MC824P	MOTOROLA	MC824P
M04	230053	INTEGRATED CIRCUIT MC892P	MOTOROLA	MC892P
M05	230019	INTEGRATED CIRCUIT MC824P	MOTOROLA	MC824P
M06	230018	INTEGRATED CIRCUIT MC817P	MOTOROLA	MC817P
M07	230023	INTEGRATED CIRCUIT MC890P	MOTOROLA	MC890P
M08	230023	INTEGRATED CIRCUIT MC890P	MOTOROLA	MC890P
M09	230052	INTEGRATED CIRCUIT MC879P	MOTOROLA	MC879P
M10	230049	INTEGRATED CIRCUIT CUL9958	FAIRCHILD	CUL9958
M11	230049	INTEGRATED CIRCUIT CUL9958	FAIRCHILD	CUL9958
M12	230049	INTEGRATED CIRCUIT CUL9958	FAIRCHILD	CUL9958
M13	230049	INTEGRATED CIRCUIT CUL9958	FAIRCHILD	CUL9958
M14	230050	INTEGRATED CIRCUIT CUL9959	FAIRCHILD	CUL9959
M15	230050	INTEGRATED CIRCUIT CUL9959	FAIRCHILD	CUL9959
M16	230050	INTEGRATED CIRCUIT CUL9959	FAIRCHILD	CUL9959
M17	230050	INTEGRATED CIRCUIT CUL9959	FAIRCHILD	CUL9959
M18	230049	INTEGRATED CIRCUIT CUL9958	FAIRCHILD	CUL9958

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PARTS LIST

ASSEMBLY 403446 READOUT 5200

REF. DESIG.	PART NO.	DESCRIPTION	
M19	230014	INTEGRATED CIRCUIT UL9960	FAIRCHILD UL9960
M20	230014	INTEGRATED CIRCUIT UL9960	FAIRCHILD UL9960
M21	230014	INTEGRATED CIRCUIT UL9960	FAIRCHILD UL9960
M22	230014	INTEGRATED CIRCUIT UL9960	FAIRCHILD UL9960
M23	230014	INTEGRATED CIRCUIT UL9960	FAIRCHILD UL9960
M24	230050	INTEGRATED CIRCUIT CUL9959	FAIRCHILD CUL9959
M25	230054	INTEGRATED CIRCUIT LM301A	NAT SEMI LM301A
M26	230054	INTEGRATED CIRCUIT LM301A	NAT SEMI LM301A
M27	230026	INTEGRATED CIRCUIT MC709C	MOTOROLA MC709C
M28	230054	INTEGRATED CIRCUIT LM301A	NAT SEMI LM301A
C01	200087	TRANS SILICO 021	MOTOROLA SPS1226
C02	200087	TRANS SILICO 021	MOTOROLA SPS1226
C03	200087	TRANS SILICO 021	MOTOROLA SPS1226
C04	200087	TRANS SILICO 021	MOTOROLA SPS1226
C05	200087	TRANS SILICO 021	MOTOROLA SPS1226
C06	200087	TRANS SILICO 021	MOTOROLA SPS1226
C07	200087	TRANS SILICO 021	MOTOROLA SPS1226
C08	200087	TRANS SILICO 021	MOTOROLA SPS1226
C09	200037	TRANS SILICO NPN 2N3646	FAIRCHILD 2N3646
C10	200043	TRANS SILICO NPN 2N3565	FAIRCHILD 2N3565
C11	200052	TRANS SILICO PNP 009	DANA 200052
C12	200022	TRANS SILICO PNP 012	DANA 200022
C13	200035	TRANS SILICO NPN 014	DANA 200035
C14	200052	TRANS SILICO PNP 009	DANA 200052
C15	200037	TRANS SILICO NPN 2N3646	FAIRCHILD 2N3646
C16	200022	TRANS SILICO PNP 012	DANA 200022
C17	200043	TRANS SILICO NPN 2N3565	FAIRCHILD 2N3565
C18	200022	TRANS SILICO PNP 012	DANA 200022
C19	200022	TRANS SILICO PNP 012	DANA 200022
C20	200043	TRANS SILICO NPN 2N3565	FAIRCHILD 2N3565
Q21	200103	TRANS TIS 74	TI TIS 74
C22	200103	TRANS TIS 74	TI TIS 74
C23	200103	TRANS TIS 74	TI TIS 74
C24	200103	TRANS TIS 74	TI TIS 74
C25	200043	TRANS SILICO NPN 2N3565	FAIRCHILD 2N3565
C26	200043	TRANS SILICO NPN 2N3565	FAIRCHILD 2N3565
R01	000302	RES CARBON 3 K 5% 1/4 W	OHMITE RC07GF302J
R02	030020	RES CARBON 56 K 5% 1 W	OHMITE RC32GF563J

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PARTS LIST

ASSEMBLY 403446 READOUT 5200

REF. DESIG.	PART NO.	DESCRIPTION						
R03	030020	RES	CARBON	56 K	5%	1 W	OHMITE	RC32GF563J
R04	030020	RES	CARBON	56 K	5%	1 W	OHMITE	RC32GF563J
R05	030020	RES	CARBON	56 K	5%	1 W	OHMITE	RC32GF563J
R06	030020	RES	CARBON	56 K	5%	1 W	OHMITE	RC32GF563J
R07	CC0623	RES	CARBON	62 K	5%	1/4 W	OHMITE	RC07GF623J
R08	CC0623	RES	CARBON	62 K	5%	1/4 W	OHMITE	RC07GF623J
R09	C00105	RES	CARBON	1 M	5%	1/4 W	OHMITE	RC07GF105J
R10	CC0623	RES	CARBON	62 K	5%	1/4 W	OHMITE	RC07GF623J
R11	CC0302	RES	CARBON	3 K	5%	1/4 W	OHMITE	RC07GF302J
R12	CC0302	RES	CARBON	3 K	5%	1/4 W	OHMITE	RC07GF302J
R13	CC0302	RES	CARBON	3 K	5%	1/4 W	OHMITE	RC07GF302J
R14	000331	RES	CARBON	330 OHM	5%	1/4 W	OHMITE	RC07GF331J
R15	CC0391	RES	CARBON	390 OHM	5%	1/4 W	OHMITE	RC07GF391J
R16	CC0391	RES	CARBON	390 OHM	5%	1/4 W	OHMITE	RC07GF391J
R17	C00391	RES	CARBON	390 OHM	5%	1/4 W	OHMITE	RC07GF391J
R18	C00122	RES	CARBON	1.2 K	5%	1/4 W	OHMITE	RC07GF122J
R20	000302	RES	CARBON	3 K	5%	1/4 W	OHMITE	RC07GF302J
R21	CC0302	RES	CARBON	3 K	5%	1/4 W	OHMITE	RC07GF302J
R22	CC0302	RES	CARBON	3 K	5%	1/4 W	OHMITE	RC07GF302J
R23	CC0302	RES	CARBON	3 K	5%	1/4 W	OHMITE	RC07GF302J
R24	C00202	RES	CARBON	2 K	5%	1/4 W	OHMITE	RC07GF202J
R25	C00202	RES	CARBON	2 K	5%	1/4 W	OHMITE	RC07GF202J
R26	CC0511	RES	CARBON	510 OHM	5%	1/4 W	OHMITE	RC07GF511J
R27	CC0203	RES	CARBON	20 K	5%	1/4 W	OHMITE	RC07GF203J
R28	C00203	RES	CARBON	20 K	5%	1/4 W	OHMITE	RC07GF203J
R29	CC0202	RES	CARBON	2 K	5%	1/4 W	OHMITE	RC07GF202J
R30	000302	RES	CARBON	3 K	5%	1/4 W	OHMITE	RC07GF302J
R32	CC0152	RES	CARBON	1.5 K	5%	1/4 W	OHMITE	RC07GF152J
R33	CC0122	RES	CARBON	1.2 K	5%	1/4 W	OHMITE	RC07GF122J
R34	CC0102	RES	CARBON	1 K	5%	1/4 W	OHMITE	RC07GF102J
R35	CC0332	RES	CARBON	3.3 K	5%	1/4 W	OHMITE	RC07GF332J
R36	C00202	RES	CARBON	2 K	5%	1/4 W	OHMITE	RC07GF202J
R37	CC0101	RES	CARBON	100 OHM	5%	1/4 W	OHMITE	RC07GF101J
R38	CC0101	RES	CARBON	100 OHM	5%	1/4 W	OHMITE	RC07GF101J
R39	C01742	RES	CARBON	300 OHM	5%	1/2 W	OHMITE	RC20GF301J
R40	C01742	RES	CARBON	300 OHM	5%	1/2 W	OHMITE	RC20GF301J
R41	C00202	RES	CARBON	2 K	5%	1/4 W	OHMITE	RC07GF202J

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PARTS LIST

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REF. DESIG.	PART NO.	DESCRIPTION						
R42	CC1742	RES	CARBON	300 OHM	5%	1/2 W	OHMITE	RC20GF301J
R43	CC0132	RES	CARBON	1.3 K	5%	1/4 W	OHMITE	RC07GF132J
R44	CC0202	RES	CARBON	2 K	5%	1/4 W	OHMITE	RC07GF202J
R45	CC0203	RES	CARBON	20 K	5%	1/4 W	OHMITE	RC07GF203J
R46	CC0152	RES	CARBON	1.5 K	5%	1/4 W	OHMITE	RC07GF152J
R47	CC0512	RES	CARBON	5.1 K	5%	1/4 W	OHMITE	RC07GF512J
R48	CC0153	RES	CARBON	15 K	5%	1/4 W	OHMITE	RC07GF153J
R49	CC0202	RES	CARBON	2 K	5%	1/4 W	OHMITE	RC07GF202J
R50	CC0510	RES	CARBON	51 OHM	5%	1/4 W	OHMITE	RC07GF510J
R51	000203	RES	CARBON	20 K	5%	1/4 W	OHMITE	RC07GF203J
R52	CC0393	RES	CARBON	39 K	5%	1/4 W	OHMITE	RC07GF393J
R53	C10292	RES	METAL	200 K	.25%	1/2 W	PYRCFILM	PME65T200K
R54	CC0104	RES	CARBON	100 K	5%	1/4 W	OHMITE	RC07GF104J
R55	CC0105	RES	CARBON	1 M	5%	1/4 W	OHMITE	RC07GF105J
R56	000105	RES	CARBON	1 M	5%	1/4 W	OHMITE	RC07GF105J
R57	CC0104	RES	CARBON	100 K	5%	1/4 W	OHMITE	RC07GF104J
R58	C10158	RES	METAL	200 K	1%	1/4 W	ELECTRA	RN60D2003F
R59	CC0821	RES	CARBON	820 OHM	5%	1/4 W	OHMITE	RC07GF821J
R60	C00206	RES	CARBON	20 M	5%	1/4 W	OHMITE	RC07GF206J
R61	000106	RES	CARBON	10 M	5%	1/4 W	OHMITE	RC07GF106J
R62	C00275	RES	CARBON	2.7 M	5%	1/4 W	OHMITE	RC07GF275J
R63	C40092	RES	VARI	20 K			SPECTRO	50-3-1-203
R64	000825	RES	CARBON	8.5 MEG	5%	1/4 W	OHMITE	RC07GF825J
R65	C40123	RES	VARI	1 K			BECKMAN	62PRIK
R66	000203	RES	CARBON	20 K	5%	1/4 W	OHMITE	RC07GF203J
R67	403294	BRIDGE ELEMENT					DANA	403294
R68	000242	RES	CARBON	2.4 K	5%	1/4 W	OHMITE	RC07GF242J
R69	403294	BRIDGE ELEMENT					DANA	403294
R70	000335	RES	CARBON	3.3 M	5%	1/4 W	OHMITE	RC07GF335J
R71	000300	RES	CARBON	30 OHM	5%	1/4 W	OHMITE	RC07GF300J
R72	CC0333	RES	CARBON	33 K	5%	1/4 W	OHMITE	RC07GF333J
R73	CC0203	RES	CARBON	20 K	5%	1/4 W	OHMITE	RC07GF203J
R74	020552	RES	WW	3.9976 K	.05%	1/4 W	JORDAN	J12
R75	CC0132	RES	CARBON	1.3 K	5%	1/4 W	OHMITE	RC07GF132J
R76	040092	RES	VARI	20 K			SPECTRO	50-3-1-203
R77	000203	RES	CARBON	20 K	5%	1/4 W	OHMITE	RC07GF203J
R78	020571	RES	WW	SET			DANA	020571
R79	000120	RES	CARBON	12 OHM	5%	1/4 W	OHMITE	RC07GF120J

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PARTS LIST

ASSEMBLY 403446 READOUT 5200

REF. DESIG.	PART NO.	DESCRIPTION						
R80	040028	RES	VARI	100 OHM			SPECTROL	51-3-11-101
R81	000512	RES	CARBON	5.1 K	5%	1/4 W	CHMITE	RC07GF512J
R85	020571	RES	WW	SET			DANA	020571
R86	020533	RES	WW	9 K	.1%		JORDAN	J11
R87	020139	RES	WW	1 K	.1%	1/8 W	KELVIN	J-11
Y01	920301	CRYSTAL		1MHZ			DANA	920301

FORM NO. 10110-P

PARTS LIST

ASSEMBLY 403304 ISOLATOR 5200

REF. DESIG.	PART NO.	DESCRIPTION						
CR01	211083	DIODE SILICO		018		1	DANA	211083
CR02	211083	DIODE SILICO		018		1	DANA	211083
CR03	211083	DIODE SILICO		018		1	DANA	211083
CR04	211083	DIODE SILICO		018		1	DANA	211083
CR05	211083	DIODE SILICO		018		1	DANA	211083
CR06	211083	DIODE SILICO		018		1	DANA	211083
CR08	211083	DIODE SILICO		018		1	DANA	211083
CR09	211083	DIODE SILICO		018		1	DANA	211083
CR10	220007	DIODE SILICO	ZENER	1N751		1	MOTOROLA	1N751
CR11	220004	DIODE SILICO	ZENER	1N961B		1	MOTOROLA	1N961B
CR12	220004	DIODE SILICO	ZENER	1N961B		1	MOTOROLA	1N961B
CR13	211236	DIODE SILICO		007			DANA	211236
CR14	220022	DIODE SILICO	ZENER	IN965B			MOTOROLA	IN965B
CR15	220022	DIODE SILICO	ZENER	IN965B			MOTOROLA	IN965B
CR16	211236	DIODE SILICO		007			DANA	211236
CR17	211236	DIODE SILICO		007			DANA	211236
CR18	211236	DIODE SILICO		007			DANA	211236
CR19	211083	DIODE SILICO		018		1	DANA	211083
CR20	211083	DIODE SILICO		018		1	DANA	211083
CR21	220004	DIODE SILICO	ZENER	1N961B		1	MOTOROLA	1N961B
CR22	220012	DIODE SILICO	ZENER	1N958B		1	MOTOROLA	1N958B
CR23	221177	DIODE SILICO	ZENER		1/4 W	1	MOTOROLA	M.2.4A25
CR24	220004	DIODE SILICO	ZENER	1N961B		1	MOTOROLA	1N961B
CR25	211083	DIODE SILICO		018		1	DANA	211083
CR26	211083	DIODE SILICO		018		1	DANA	211083
CR27	221177	DIODE SILICO	ZENER		1/4 W	1	MOTOROLA	M.2.4A25
CR28	211083	DIODE SILICO		018		1	DANA	211083
CR29	211083	DIODE SILICO		018		1	DANA	211083
CR30	220016	DIODE SILICO	ZENER	1N964B			MOTOROLA	1N964B
CR31	220016	DIODE SILICO	ZENER	1N964B			MOTOROLA	1N964B
C01	110086	CAP	TANTA	47 MFD	10 V	10%	KEMET	K47C6K
C02	101174	CAP	CERAM	.001 MFD	500 V	10%1	AEROVOX	SCD3X5F
C03	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C04	120177	CAP	MYLAR	.56 MFD	50 V	5%	IMB	PV2A564J
C05	110071	CAP	ELEC	.1 MFD	35 V	10%	KEMET	K1W35K
C06	110071	CAP	ELECT	.1 MFD	35 V	10%	KEMET	K1W35K
C07	120175	CAP	MYLAR	.0027 MFD	100 V	10%	IMB	ZA1296K
C08	121093	CAP	MYLAR	.047 MFD	100 V	10%1	CDE	WMF1S47
C09	120135	CAP	POLYS	.015 MFD	33 V	10%	MIAL	611.3S
C10	120178	CAP	MYLAR	.27 MFD	50 V	5%	IMB	PV2A274J

PARTS LIST

ASSEMBLY 403304 ISOLATOR S200

REF. DESIG.	PART NO.	DESCRIPTION
C11	120153	CAP POLYS 47 PFD 125 V 10% MIAL 611
C12	110047	CAP ELECT 50 MFD 50 V 20% DUCATI 50-50
C13	120026	CAP MYLAR .47 MFD 100 V 10%1 IMB AS2B474K
C14	101174	CAP CERAM .001 MFD 500 V 10%1 AEROVOX SCD3X5F
C15	120176	CAP POLY 150 PFD 63 V 20% MIAL 611.1
C16	101174	CAP CERAM .001 MFD 500 V 10%1 AEROVOX SCD3X5F
C17	100017	CAP CERAM .01 MFD 200 V 10% SPRAGUE TH-S10
C18	110040	CAP ELECT 1 MFD 50 V 20% DUCATI 1-50
C19	120185	CAP MYLAR .33 MFD 100 V 10% CD WMF1P33
C20	110040	CAP ELECT 1 MFD 50 V 20% DUCATI 1-50
C21	120134	CAP MYLAR 1 MFD 200 V 10% PAKTRON MF1200LL
C22	120134	CAP MYLAR 1 MFD 200 V 10% PAKTRON MF1200LL
C23	120110	CAP MYLAR .27 MFD 100 V 10% CD WMF1P27
K01	310029	RELAY AM ZETTLR AZ420-56
K02	310021	RELAY DC 2 PDT 24V 1 ALLIED AZ42056105
M01	230019	INTEGRATED CIRCUIT MC824P MOTOROLA MC824P
M02	230023	INTEGRATED CIRCUIT MC890P MOTOROLA MC890P
M03	230018	INTEGRATED CIRCUIT MC817P MOTOROLA MC817P
M04	230055	INTEGRATED CIRCUIT MC819P MOTOROLA MC819P
M05	230015	INTEGRATED CIRCUIT MC723P MOTOROLA MC723P
M06	230053	INTEGRATED CIRCUIT MC892P MOTOROLA MC892P
M07	230019	INTEGRATED CIRCUIT MC824P MOTOROLA MC824P
M08	230055	INTEGRATED CIRCUIT MC819P MOTOROLA MC819P
M09	230018	INTEGRATED CIRCUIT MC817P MOTOROLA MC817P
M10	230018	INTEGRATED CIRCUIT MC817P MOTOROLA MC817P
M11	230022	INTEGRATED CIRCUIT MC889P MOTOROLA MC889P
Q01	200043	TRANS SILICO NPN 2N3565 FAIRCHILD 2N3565
Q02	200043	TRANS SILICO NPN 2N3565 FAIRCHILD 2N3565
Q04	200104	TRANS SILICO MPS-6571 MOTOROLA MPS-6571
Q05	200104	TRANS SILICO MPS-6571 MOTOROLA MPS-6571
Q06	200043	TRANS SILICO NPN 2N3565 FAIRCHILD 2N3565
Q07	200043	TRANS SILICO NPN 2N3565 FAIRCHILD 2N3565
Q08	200022	TRANS SILICO PNP 012 DANA 200022
Q09	201084	TRANS GERMAN PNP 2N1304 1 TI 2N1304
Q10	200027	TRANS SILICO FSV DANA 200027
Q11	200043	TRANS SILICO NPN 2N3565 FAIRCHILD 2N3565
Q12	200043	TRANS SILICO NPN 2N3565 FAIRCHILD 2N3565
Q13	200043	TRANS SILICO NPN 2N3565 FAIRCHILD 2N3565

PARTS LIST

ASSEMBLY 403304 ISOLATOR 5200

REF. DESIG.	PART NO.	DESCRIPTION						
Q14	200043	TRANS SILICO NPN	2N3565				FAIRCHILD	2N3565
Q15	200052	TRANS SILICO PNP	009				DANA	200052
Q16	200035	TRANS SILICO NPN	014				DANA	200035
Q17	200083	TRANS DUAL	TIS34				DANA	200083
Q18	200083	TRANS DUAL	TIS34				DANA	200083
Q19	200022	TRANS SILICO PNP	012				DANA	200022
Q20	200043	TRANS SILICO NPN	2N3565				FAIRCHILD	2N3565
Q21	200022	TRANS SILICO PNP	012				DANA	200022
Q22	200022	TRANS SILICO PNP	012				DANA	200022
Q23	200043	TRANS SILICO NPN	2N3565				FAIRCHILD	2N3565
Q24	200043	TRANS SILICO NPN	2N3565				FAIRCHILD	2N3565
Q25	200022	TRANS SILICO PNP	012				DANA	200022
Q26	200037	TRANS SILICO NPN	2N3646				FAIRCHILD	2N3646
R01	000561	RES CARBON	560 OHM	5%	1/4 W1		OHMITE	RC07GF561J
R03	000104	RES CARBON	100 K	5%	1/4 W1		OHMITE	RC07GF104J
R04	000102	RES CARBON	1 K	5%	1/4 W1		OHMITE	RC07GF102J
R05	000102	RES CARBON	1 K	5%	1/4 W1		OHMITE	RC07GF102J
R06	000102	RES CARBON	1 K	5%	1/4 W1		OHMITE	RC07GF102J
R07	000511	RES CARBON	510 OHM	5%	1/4 W1		OHMITE	RC07GF511J
R08	000154	RES CARBON	150 K	5%	1/4 W1		OHMITE	RC07GF154J
R09	000202	RES CARBON	2 K	5%	1/4 W1		OHMITE	RC07GF202J
R10	000202	RES CARBON	2 K	5%	1/4 W1		OHMITE	RC07GF202J
R12	030015	RES WW	100 K	1%	10 W		C-F	M-100
R13	040093	RES VARI	500 OHM				SPECTRO	50-3-1-501
R14	010334	RES	SET				DANA	010334
R15	010334	RES	SET				DANA	010334
R16	000513	RES CARBON	51 K	5%	1/4 W1		OHMITE	RC07GF513J
R17	000515	RES CARBON	5.1 M	5%	1/4 W		OHMITE	RC07GF515J
R18	000105	RES CARBON	1 M	5%	1/4 W1		OHMITE	RC07GF105J
R19	000105	RES CARBON	1 M	5%	1/4 W1		OHMITE	RC07GF105J
R20	000245	RES CARBON	2.4 M	5%	1/4 W		OHMITE	RC07GF245J
R21	000563	RES CARBON	56 K	5%	1/4 W		OHMITE	RC07GF563J
R22	000301	RES CARBON	300 OHM	5%	1/4 W		OHMITE	RC07GF301J
R23	000472	RES CARBON	4.7 K	5%	1/4 W1		OHMITE	RC07GF472J
R24	000103	RES CARBON	10 K	5%	1/4 W1		OHMITE	RC07GF103J
R25	000750	RES CARBON	75 OHM	5%	1/4 W1		OHMITE	RC07GF750J
R26	040109	RES VARI	5 K				SPECTROL	50-3

PARTS LIST

ASSEMBLY 403304 ISOLATOR 5200

A

REF. DESIG.	PART NO.	DESCRIPTION						
R27	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R28	000203	RES	CARBON	20 K	5%	1/4 W1	OHMITE	RC07GF203J
R29	000104	RES	CARBON	100 K	5%	1/4 W1	OHMITE	RC07GF104J
R30	000516	RES	CARBON	51 M	5%	1/4 W	OHMITE	RC07GF516J
R32	010337	RES	METAL	10 MEG	1%		DALE	DCS1/2
R33	010337	RES	METAL	10 MEG	1%		DALE	DCS1/2
R34	000103	RES	CARBON	10 K	5%	1/4 W1	OHMITE	RC07GF103J
R35	040134	RES	VARI	200 K			CTS	134
R36	000915	RES	CARBON	910 K	5%	1/4 W	OHMITE	RC07GF915J
R38	010337	RES	METAL	10 MEG	1%		DALE	DCS1/2
R39	010337	RES	METAL	10 MEG	1%		DALE	DCS1/2
R40	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R41	000335	RES	CARBON	3.3 M	5%	1/4 W1	OHMITE	RC07GF335J
R42	000685	RES	CARBON	6.8 MEG	5%	1/4 W	OHMITE	RC07GF685J
R43	000104	RES	CARBON	100 K	5%	1/4 W1	OHMITE	RC07GF104J
R44	000123	RES	CARBON	12 K	5%	1/4 W1	OHMITE	RC07GF123J
R45	000123	RES	CARBON	12 K	5%	1/4 W1	OHMITE	RC07GF123J
R46	000101	RES	CARBON	100 OHM	5%	1/4 W1	OHMITE	RC07GF101J
R47	000620	RES	CARBON	62 OHM	5%	1/4 W1	OHMITE	RC07GF620J
R48	000330	RES	CARBON	33 K	5%	1/4 W	OHMITE	RC07GF330J
R49	000302	RES	CARBON	3 K	5%	1/4 W1	OHMITE	RC07GF302J
R50	000302	RES	CARBON	3 K	5%	1/4 W1	OHMITE	RC07GF302J
R51	000302	RES	CARBON	3 K	5%	1/4 W1	OHMITE	RC07GF302J
R52	000304	RES	CARBON	300 K	5%	1/4 W	OHMITE	RC07GF304J
R53	000513	RES	CARBON	51 K	5%	1/4 W1	OHMITE	RC07GF513J
R54	000203	RES	CARBON	20 K	5%	1/4 W1	OHMITE	RC07GF203J
R55	000510	RES	CARBON	51 OHM	5%	1/4 W1	OHMITE	RC07GF510J
R56	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R57	000153	RES	CARBON	15 K	5%	1/4 W1	OHMITE	RC07GF153J
R58	000153	RES	CARBON	15 K	5%	1/4 W1	OHMITE	RC07GF153J
R59	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R60	000151	RES	CARBON	150 OHM	5%	1/4 W1	OHMITE	RC07GF151J
R61	000103	RES	CARBON	10 K	5%	1/4 W1	OHMITE	RC07GF103J
R62	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R63	000510	RES	CARBON	51 OHM	5%	1/4 W1	OHMITE	RC07GF510J
R64	000510	RES	CARBON	51 OHM	5%	1/4 W1	OHMITE	RC07GF510J
R65	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J

PARTS LIST

ASSEMBLY 403304 ISOLATOR 5200 A

REF. DESIG.	PART NO.	DESCRIPTION							
R66	000100	RES	CARBON	10	OHM	5%	1/4 W1	OHMITE	RC07GF100J
R67	000100	RES	CARBON	10	OHM	5%	1/4 W1	OHMITE	RC07GF100J
R68	000101	RES	CARBON	100	OHM	5%	1/4 W1	OHMITE	RC07GF101J
R69	000102	RES	CARBON	1	K	5%	1/4 W1	OHMITE	RC07GF102J
R70	040026	RES	VARI	20	K	10%	1 W	TECHNO	35
R71	020241	RES	WW	10	K	.05%	1/8 W	JORDAN	J-11
R72	000335	RES	CARBON	3.3	M	5%	1/4 W1	OHMITE	RC07GF335J
R73	020554	RES	WW	1.1096	K	.05%		JORDAN	J11

PARTS LIST

ASSEMBLY 403214 PCB Assembly, AC Converter A

REF. DESIG.	PART NO.	DESCRIPTION							
CR 101	211236	DIODE	SILICO		007			DANA	211236
CR 102	211236	DIODE	SILICO		007			DANA	211236
CR 103	221177	DIODE	SILICO	ZENER		1/4 W1		MOTOROLA	M.2.4A25
CR 104	221177	DIODE	SILICO	ZENER		1/4 W1		MOTOROLA	M.2.4A25
CR 105	220015	DIODE	SILICO	ZENER	1N967B			MOTOROLA	1N967B
CR 106	220015	DIODE	SILICO	ZENER	1N967B			MOTOROLA	1N967B
CR 107	211083	DIODE	SILICO		018		1	DANA	211083
CR 108	211083	DIODE	SILICO		018		1	DANA	211083
CR 109	211083	DIODE	SILICO		018		1	DANA	211083
CR 110	211083	DIODE	SILICO		018		1	DANA	211083
CR 111	211083	DIODE	SILICO		018		1	DANA	211083
C101	120007	CAP	MYLAR	.22 MFD	600 V	20%		ELEC CUBE	21081F224
C102	130054	CAP	CERAM	1-5 PFD		10%		AMPREX	C010KA/5E
C103	120186	CAP	POLYS	15 PFD	500 V	2.5%		DUCATI	15-500
C104	120197	CAP	POLYS	20 PFD	1000 V			DUCATI	20-1000
C105	120161	CAP	POLYS	.047 MFD	63 V	2.5%		DIEL	N100
C106	120162	CAP	POLYS	.0044 MFD	63 V	2.5%		MIAL	611.2D
C107	120142	CAP	POLYS	FSV				DANA	120142
C108	130055	CAP	CERAM	5-60 PFD		10%		AMPREX	C010MA/60E
C109	120158	CAP	POLYS	390 PFD	63 V	5%		MIAL	611
C110	130055	CAP	CERAM	5-60 PFD		10%		AMPREX	C010MA/60E
C111	120034	CAP	POLYS	100 PFD	500 V	5%		CRL	CPR-100J
C112	130054	CAP	CERAM	1-5 PFD		10%		AMPREX	C010KA/5E
C113	120138	CAP	POLYS	20 PFD	630 V	5%		MIAL	611
C114	120198	CAP	POLYS	12 PFD	500 V	20%		MALLORY	SX412
C115	111148	CAP	ELECT	100 MFD	25 V	20%1		SPRAGUE	TE1211
C116	110047	CAP	ELECT	50 MFD	50 V	20%		DUCATI	50-50
C117	110047	CAP	ELECT	50 MFD	50 V	20%		DUCATI	50-50
C118	121393	CAP	MYLAR	.22 MFD	100 V	10%		CDE	WMF1P22
C119	101145	CAP	CERAM	100 PFD	500 V	10%1		AEROVOX	SCD1X5F
C120	100008	CAP	CERAM	82 PFD	500 V	10%		AEROVOX	TCD-N750
C121	101145	CAP	CERAM	100 PFD	500 V	10%1		AEROVOX	SCD1X5F
C122	110005	CAP	TANTA	10 MFD	50 V	10%1		SEMCOR	TSW1K-50-10
C123	110022	CAP	TANTA	3.3 MFD	35 V	10%1		KEMET	K33C35K
C124	110022	CAP	TANTA	3.3 MFD	35 V	10%1		KEMET	K33C35K
K101	310035	RELAY	REED		SPST	24V		AZTEC	LIA24-S1
K102	310035	RELAY	REED		SPST	24V		AZTEC	LIA24-S1
K103	310036	RELAY	REED					ELEC-TROL	R2096-3

PARTS LIST

ASSEMBLY 403214 PCB Assembly, AC Converter

REF. DESIG.	PART NO.	DESCRIPTION							
C101	200085	TRANS			MPF103			MOTOROLA	MPF103
C102	200022	TRANS	SILICO	PNP	012			DANA	200022
C103	200052	TRANS	SILICO	PNP	009			DANA	200052
C104	200090	TRANS	SILICO	NPN	SELECTED			FAIRCHILD	2N3565
C105	200090	TRANS	SILICO	NPN	SELECTED			FAIRCHILD	2N3565
C106	200022	TRANS	SILICO	PNP	012			DANA	200022
C107	200043	TRANS	SILICO	NPN	2N3565			FAIRCHILD	2N3565
C108	200076	TRANS			2N4250			FAIRCHILD	2N4250
C109	200052	TRANS	SILICO	PNP	009			DANA	200052
C110	200035	TRANS	SILICO	NPN	014			DANA	200035
C111	200043	TRANS	SILICO	NPN	2N3565			FAIRCHILD	2N3565
C112	200043	TRANS	SILICO	NPN	2N3565			FAIRCHILD	2N3565
C113	200043	TRANS	SILICO	NPN	2N3565			FAIRCHILD	2N3565
R101	040046	RES	VARI	20 K	10%	1/4 W		BECKMAN	62PR20K
R102	040114	RES	VARI	50 K	10%			BECKMAN	62PR50
R103	040115	RES	VARI	500 K	10%			BECKMAN	62PR500
R104	000243	RES	CARBON	24 K	5%	1/4 W1		OHMITE	RC07GF243J
R105	010356	RES	METAL	MATCH SET				DANA	010356
R106	010356	RES	METAL	MATCH SET				DANA	010356
R107	010356	RES	METAL	MATCH SET				DANA	010356
R108	010356	RES	METAL	MATCH SET				DANA	010356
R109	010356	RES	METAL	MATCH SET				DANA	010356
R110	010356	RES	METAL	MATCH SET				DANA	010356
R111	010356	RES	METAL	MATCH SET				DANA	010356
R112	010356	RES	METAL	MATCH SET				DANA	010356
R113	000104	RES	CARBON	100 K	5%	1/4 W1		OHMITE	RC07GF104J
R114	000201	RES	CARBON	200 OHM	5%	1/4 W1		OHMITE	RC07GF201J
R115	000332	RES	CARBON	3.3 K	5%	1/4 W1		OHMITE	RC07GF332J
R116	010321	RES	METAL	10 OHM	1%			ELECTRA	RN60D10R0F
R117	040110	RES	VARI	100 OHM				BBECKMAN	62PR100
R118	000102	RES	CARBON	1 K	5%	1/4 W1		OHMITE	RC07GF102J
R119	000104	RES	CARBON	100 K	5%	1/4 W1		OHMITE	RC07GF104J
R120	000752	RES	CARBON	7.5 K	5%	1/4 W1		OHMITE	RC07GF752J
R121	000106	RES	CARBON	10 M	5%	1/4 W1		OHMITE	RC07GF106J
R122	000105	RES	CARBON	1 M	5%	1/4 W1		OHMITE	RC07GF105J
R123	000104	RES	CARBON	100 K	5%	1/4 W1		OHMITE	RC07GF104J
R124	000104	RES	CARBON	100 K	5%	1/4 W1		OHMITE	RC07GF104J
R125	000106	RES	CARBON	10 M	5%	1/4 W1		OHMITE	RC07GF106J

PARTS LIST

ASSEMBLY 403214 PCB Assembly, AC Converter A

REF. DESIG.	PART NO.	DESCRIPTION							
R126	000203	RES	CARBON	20 K	5%	1/4 W1	OHMITE	RC07GF203J	
R127	C01712	RES	CARBON	750 OHM	5%	1/2 W	OHMITE	RC20GF751J	
R128	000512	RES	CARBON	5.1 K	5%	1/4 W1	OHMITE	RC07GF512J	
R129	CC0332	RES	CARBON	3.3 K	5%	1/4 W1	OHMITE	RC07GF332J	
R130	000101	RES	CARBON	100 OHM	5%	1/4 W1	OHMITE	RC07GF101J	
R131	CC0101	RES	CARBON	100 OHM	5%	1/4 W1	OHMITE	RC07GF101J	
R132	C00101	RES	CARBON	100 OHM	5%	1/4 W1	OHMITE	RC07GF101J	
R133	000751	RES	CARBON	750 OHM	5%	1/4 W1	OHMITE	RC07GF751J	
R134	C00332	RES	CARBON	3.3 K	5%	1/4 W1	OHMITE	RC07GF332J	
R135	000103	RES	CARBON	10 K	5%	1/4 W1	OHMITE	RC07GF103J	
R136	000332	RES	CARBON	3.3 K	5%	1/4 W1	OHMITE	RC07GF332J	
R137	C01712	RES	CARBON	750 OHM	5%	1/2 W	OHMITE	RC20GF751J	
R138	CCC331	RES	CARBON	330 OHM	5%	1/4 W1	OHMITE	RC07GF331J	
R139	CC0331	RES	CARBON	330 OHM	5%	1/4 W1	OHMITE	RC07GF331J	
R140	010060	RES	METAL	10 K	1%	1/4 W	ELECTRA	RN60D1002F	
R141	010356	RES	METAL	MATCH SET			DANA	010356	
R142	010356	RES	METAL	MATCH SET			DANA	010356	
R143	010060	RES	METAL	10 K	1%	1/4 W	ELECTRA	RN60D1002F	
R144	C00202	RES	CARBON	2 K	5%	1/4 W1	OHMITE	RC07GF202J	
R145	C00202	RES	CARBON	2 K	5%	1/4 W1	OHMITE	RC07GF202J	
R146	000202	RES	CARBON	2 K	5%	1/4 W1	OHMITE	RC07GF202J	

PARTS LIST

ASSEMBLY 403169 Assembly Ohms Converter

A

REF. DESIG.	PART NO.	DESCRIPTION							
CR108	211083	DIODE	SILICO		018		1	DANA	211083
CR107	211083	DIODE	SILICO		018		1	DANA	211083
CR106	211083	DIODE	SILICO		018		1	DANA	211083
CR105	211083	DIODE	SILICO		018		1	DANA	211083
CR113	221177	DIODE	SILICO	ZENER			1/4 W1	MOTOROLA	M.2.4A25
CR114	221177	DIODE	SILICO	ZENER			1/4 W1	MOTOROLA	M.2.4A25
CR115	221177	DIODE	SILICO	ZENER			1/4 W1	MOTOROLA	M.2.4A25
C123	121088	CAP	MYLAR		.01 MFD	100 V	10%	CDE	WMF1S1
C124	121146	CAP	MYLAR		.0047 MFD	100 V	10%1	CDE	WMF1D47
C127	121146	CAP	MYLAR		.0047 MFD	100 V	10%1	CDE	WMF1D47
K104	310036	RELAY	REED					ELEC-TROL	R2096-3
K105	310036	RELAY	REED					ELEC-TROL	R2096-3
K106	310035	RELAY	REED			SPST	24V	AZTEC	LIA24-S1
K107	310035	RELAY	REED			SPST	24V	AZTEC	LIA24-S1
M101	230026	INTEGRATED CIRCUIT			MC709C			MOTOROLA	MC709C
Q115	200043	TRANS	SILICO	NPN		2N3565			FAIRCHILD 2N3565
Q104	200043	TRANS	SILICO	NPN		2N3565			FAIRCHILD 2N3565
Q105	200043	TRANS	SILICO	NPN		2N3565			FAIRCHILD 2N3565
Q106	200043	TRANS	SILICO	NPN		2N3565			FAIRCHILD 2N3565
Q107	200043	TRANS	SILICO	NPN		2N3565			FAIRCHILD 2N3565
R112	000202	RES	CARBON		2 K	5%	1/4 W1	OHMITE	RC07GF202J
R114	001737	RES	FSV			5%	1/4 W	DANA	001737
R115	040159	RES	VARI		500 K		1/2 W	BECKMAN	62PR500K
R116	000202	RES	CARBON		2 K	5%	1/4 W1	OHMITE	RC07GF202J
R120	020494	RES	WW		8.19 K	.1%		JORDAN	J11
R122	020495	RES	WW		89.815 K	.1%		JORDAN	J11
R123	040115	RES	VARI		500 K	10%		BECKMAN	62PR500
R124	000202	RES	CARBON		2 K	5%	1/4 W1	OHMITE	RC07GF202J
R129	020496	RES	WW		996.15 K	.1%		JORDAN	J11
R130	040097	RES	VARI		5 K	10%		BECKMAN	62PR5K
R125	000202	RES	CARBON		2 K	5%	1/4 W1	OHMITE	RC07GF202J
R134	040104	RES	VARI		50 K			BECKMAN	62P
R135	010357	RES	METAL		8.981 MEG	.1%		PYROFILM	PME 70 T2
R145	000685	RES	CARBON		6.8 MEG	5%	1/4 W	OHMITE	RC07GF685J
R154	040088	RES	VARI		100 K	10%		BECKMAN	62PR100K
R155	001737	RES	FSV			5%	1/4 W	DANA	001737
R156	000152	RES	CARBON		1.5 K	5%	1/4 W1	OHMITE	RC07GF152J
R159	000821	RES	CARBON		820 OHM	5%	1/4 W	OHMITE	RC07GF821J

PARTS LIST

ASSEMBLY 403169 Assembly Ohms Converter

A

REF. DESIG.	PART NO.	DESCRIPTION							
R158	000512	RES	CARBON	5.1 K	5%	1/4 W1	OHMITE	RC07GF512J
R163	000912	RES	CARBON	9.1 K	5%	1/4 W1	OHMITE	RC07GF912J
R164	020050	RES	WW	9.0 K	.01%	1/4 W1	KELVIN	EP-21
R165	021395	RES	WW	1 K	.01%	1/4 W	JORDAN	J-12

PARTS LIST

ASSEMBLY 402581 AC & OHMS CONVERTER

A

REF. DESIG.	PART NO.	DESCRIPTION							
CR101	211236	DIODE SILICO		007				DANA	211236
CR102	211236	DIODE SILICO		007				DANA	211236
CR103	221177	DIODE SILICO	ZENER			1/4 W1		MOTOROLA	M.2.4A25
CR104	221177	DIODE SILICO	ZENER			1/4 W1		MOTOROLA	M.2.4A25
CR105	211083	DIODE SILICO		018			1	DANA	211083
CR106	211083	DIODE SILICO		018			1	DANA	211083
CR107	211083	DIODE SILICO		018			1	DANA	211083
CR108	211083	DIODE SILICO		018			1	DANA	211083
CR109	220015	DIODE SILICO	ZENER	1N967B				MOTOROLA	1N967B
CR110	220015	DIODE SILICO	ZENER	1N967B				MOTOROLA	1N967B
CR111	211083	DIODE SILICO		018			1	DANA	211083
CR112	211083	DIODE SILICO		018			1	DANA	211083
CR113	221177	DIODE SILICO	ZENER			1/4 W1		MOTOROLA	M.2.4A25
CR114	221177	DIODE SILICO	ZENER			1/4 W1		MOTOROLA	M.2.4A25
CR115	221177	DIODE SILICO	ZENER			1/4 W1		MOTOROLA	M.2.4A25
C 101	120007	CAP	MYLAR	.22 MFD	600 V	20%		ELEC CUBE	210B1F224
C 102	120197	CAP	POLYS	20 PFD	1000 V			DUCATI	20-1000
C 103	130054	CAP	CERAM	1-5 PFD		10%		AMPREX	C010KA/5E
C 104	120186	CAP	POLYS	15 PFD	500 V	2.5%		DUCATI	15-500
C 105	120161	CAP	POLYS	.047 MFD	63 V	2.5%		DIEL	N100
C106	120162	CAP	POLYS	.0044 MFD	63 V	2.5%		MIAL	611.2D
C107	120142	CAP	POLYS	FSV				DANA	120142
C108	130055	CAP	CERAM	5-60 PFD		10%		AMPREX	C010MA/60E
C109	120158	CAP	POLYS	390 PFD	63 V	5%		MIAL	611
C110	130055	CAP	CERAM	5-60 PFD		10%		AMPREX	C010MA/60E
C111	120034	CAP	POLYS	100 PFD	500 V	5%		CRL	CPR-100J
C112	130054	CAP	CERAM	1-5 PFD		10%		AMPREX	C010KA/5E
C113	120138	CAP	POLYS	20 PFD	630 V	5%		MIAL	611
C114	120198	CAP	POLYS	12 PFD	500 V	20%		MALLORY	SX412
C115	111148	CAP	ELECT	100 MFD	25 V	20%1		SPRAGUE	TE1211
C116	110047	CAP	ELECT	50 MFD	50 V	20%		DUCATI	50-50
C117	110047	CAP	ELECT	50 MFD	50 V	20%		DUCATI	50-50
C118	121393	CAP	MYLAR	.22 MFD	100 V	10%		CDE	WMF1P22
C119	101145	CAP	CERAM	100 PFD	500 V	10%1		AEROVOX	SCD1X5F
C120	100008	CAP	CERAM	82 PFD	500 V	10%		AEROVOX	TCD-N750
C121	101145	CAP	CERAM	100 PFD	500 V	10%1		AEROVOX	SCD1X5F
C122	110005	CAP	TANTA	10 MFD	50 V	10%1		SEMCOR	TSW1K-50-10
C123	121088	CAP	MYLAR	.01 MFD	100 V	10%		CDE	WMF1S1

PARTS LIST

ASSEMBLY 402581 AC & OHMS CONVERTER

A

REF. DESIG.	PART NO.	DESCRIPTION							
C124	121146	CAP	MYLAR	.0047 MFD	100 V	10%1		CDE	WMF1D47
C125	110022	CAP	TANTA	3.3 MFD	35 V	10%1		KEMET	K33C35K
C126	110022	CAP	TANTA	3.3 MFD	35 V	10%1		KEMET	K33C35K
C127	121146	CAP	MYLAR	.0047 MFD	100 V	10%1		CDE	WMF1D47
K101	310036	RELAY	REED					ELEC-TROL	R2096-3
K102	310035	RELAY	REED	SPST	24V			AZTEC	LIA24-S1
K103	310035	RELAY	REED	SPST	24V			AZTEC	LIA24-S1
K104	310036	RELAY	REED					ELEC-TROL	R2096-3
K105	310036	RELAY	REED					ELEC-TROL	R2096-3
K106	310035	RELAY	REED	SPST	24V			AZTEC	LIA24-S1
K107	310035	RELAY	REED	SPST	24V			AZTEC	LIA24-S1
M101	230026	INTEGRATED CIRCUIT		MC709C				MOTOROLA	MC709C
Q101	200085	TRANS		MPF103				MOTOROLA	MPF103
Q102	200022	TRANS	SILICO PNP	012				DANA	200022
Q103	200011	TRANS	SILICO PNP	009				DANA	200011
Q104	200043	TRANS	SILICO NPN	2N3565				FAIRCHILD	2N3565
Q105	200043	TRANS	SILICO NPN	2N3565				FAIRCHILD	2N3565
Q106	200043	TRANS	SILICO NPN	2N3565				FAIRCHILD	2N3565
Q107	200043	TRANS	SILICO NPN	2N3565				FAIRCHILD	2N3565
Q108	200090	TRANS	SILICO NPN	SELECTED				FAIRCHILD	2N3565
Q109	200090	TRANS	SILICO NPN	SELECTED				FAIRCHILD	2N3565
Q110	200022	TRANS	SILICO PNP	012				DANA	200022
Q111	200043	TRANS	SILICO NPN	2N3565				FAIRCHILD	2N3565
Q112	200076	TRANS		2N4250				FAIRCHILD	2N4250
Q113	200011	TRANS	SILICO PNP	009				DANA	200011
Q114	200035	TRANS	SILICO NPN	014				DANA	200035
Q115	200043	TRANS	SILICO NPN	2N3565				FAIRCHILD	2N3565
R101	010356	RES	METAL	MATCH SET				DANA	010356
R102	010356	RES	METAL	MATCH SET				DANA	010356
R103	040046	RES	VARI	20 K	10%	1/4 W		BECKMAN	62PR20K
R104	000243	RES	CARBON	24 K	5%	1/4 W		OHMITE	RC07GF243J
R105	040114	RES	VARI	50 K	10%			BECKMAN	62PR50
R106	010356	RES	METAL	MATCH SET				DANA	010356
R107	040115	RES	VARI	500 K	10%			BECKMAN	62PR500
R108	010356	RES	METAL	MATCH SET				DANA	010356
R109	010356	RES	METAL	MATCH SET				DANA	010356
R110	000201	RES	CARBON	200 OHM	5%	1/4 W1		OHMITE	RC07GF201J
R111	000104	RES	CARBON	100 K	5%	1/4 W1		OHMITE	RC07GF104J

PARTS LIST

ASSEMBLY 402581 AC & OHMS CONVERTER

A

REF. DESIG.	PART NO.	DESCRIPTION							
R 112	000202	RES	CARBON	2	K	5%	1/4 W1	OHMITE	RC07GF202J
R 113	CC0332	RES	CARBON	3.3	K	5%	1/4 W1	OHMITE	RC07GF332J
R 114	001737	RES	FSV			5%	1/4 W	DANA	001737
R 115	040159	RES	VARI	500	K		1/2 W	BECKMAN	62PR500K
R 116	C00102	RES	CARBON	1	K	5%	1/4 W1	OHMITE	RC07GF102J
R 117	010321	RES	METAL	10	OHM	1%		ELECTRA	RN60D10R0F
R 118	C40110	RES	VARI	100	OHM			BBECKMAN	62PR100
R 119	000102	RES	CARBON	1	K	5%	1/4 W1	OHMITE	RC07GF102J
R 120	C20494	RES	WW	8.19	K	.1%		JORDAN	J11
R 121	010356	RES	METAL	MATCH	SET			DANA	010356
R 122	020495	RES	WW	89.815	K	.1%		JORDAN	J11
R 123	040115	RES	VARI	500	K	10%		BECKMAN	62PR500
R 124	CC0102	RES	CARBON	1	K	5%	1/4 W1	OHMITE	RC07GF102J
R 125	000102	RES	CARBON	1	K	5%	1/4 W1	OHMITE	RC07GF102J
R 126	000104	RES	CARBON	100	K	5%	1/4 W1	OHMITE	RC07GF104J
R 127	CC0752	RES	CARBON	7.5	K	5%	1/4 W1	OHMITE	RC07GF752J
R 128	000105	RES	CARBON	1	M	5%	1/4 W1	OHMITE	RC07GF105J
R 129	C20496	RES	WW	996.15	K	.1%		JORDAN	J11
R 130	C40097	RES	VARI	5	K	10%		BECKMAN	62PR5K
R 131	000106	RES	CARBON	10	M	5%	1/4 W1	OHMITE	RC07GF106J
R 132	000104	RES	CARBON	100	K	5%	1/4 W1	OHMITE	RC07GF104J
R 133	CC0104	RES	CARBON	100	K	5%	1/4 W1	OHMITE	RC07GF104J
R 134	040104	RES	VARI	50	K			BECKMAN	62P
R 135	010357	RES	METAL	8.981	MEG	.1%		PYROFILM	PME 70 T2
R 136	C00203	RES	CARBON	20	K	5%	1/4 W1	OHMITE	RC07GF203J
R 137	010356	RES	METAL	MATCH	SET			DANA	010356
R 138	010356	RES	METAL	MATCH	SET			DANA	010356
R 139	000106	RES	CARBON	10	M	5%	1/4 W1	OHMITE	RC07GF106J
R 140	CC0332	RES	CARBON	3.3	K	5%	1/4 W1	OHMITE	RC07GF332J
R 141	000512	RES	CARBON	5.1	K	5%	1/4 W1	OHMITE	RC07GF512J
R 142	CC0751	RES	CARBON	750	OHM	5%	1/4 W1	OHMITE	RC07GF751J
R 143	CC0103	RES	CARBON	10	K	5%	1/4 W1	OHMITE	RC07GF103J
R 144	C01712	RES	CARBON	750	OHM	5%	1/2 W	OHMITE	RC20GF751J
R 145	CC0685	RES	CARBON	6.8	MEG	5%	1/4 W	OHMITE	RC07GF685J
R 146	001712	RES	CARBON	750	OHM	5%	1/2 W	OHMITE	RC20GF751J
R 147	CC0332	RES	CARBON	3.3	K	5%	1/4 W1	OHMITE	RC07GF332J
R 148	C00101	RES	CARBON	100	OHM	5%	1/4 W1	OHMITE	RC07GF101J
R 149	CC0101	RES	CARBON	100	OHM	5%	1/4 W1	OHMITE	RC07GF101J

ASSEMBLY 402581 AC & OHMS CONVERTER

A

REF. DESIG.	PART NO.	DESCRIPTION							
R150	000332	RES	CARBON	3.3 K	5%	1/4 W1	OHMITE	RC07GF332J	
R151	000101	RES	CARBON	100 OHM	5%	1/4 W1	OHMITE	RC07GF101J	
R152	000331	RES	CARBON	330 OHM	5%	1/4 W1	OHMITE	RC07GF331J	
R153	000331	RES	CARBON	330 OHM	5%	1/4 W1	OHMITE	RC07GF331J	
R154	040098	RES	VARI	100 K	10%		BECKMAN	62PR100K	
R155	001737	RES	FSV		5%	1/4 W	DANA	001737	
R156	000152	RES	CARBON	1.5 K	5%	1/4 W1	OHMITE	RC07GF152J	
R157	010356	RES	METAL	MATCH SET			DANA	010356	
R158	000512	RES	CARBON	5.1 K	5%	1/4 W1	OHMITE	RC07GF512J	
R159	000821	RES	CARBON	820 OHM	5%	1/4 W	OHMITE	RC07GF821J	
R160	010141	RES	METAL	10 K	.25%	1/4 W	PYROFILM	PME6010	
R161	010356	RES	METAL	MATCH SET			DANA	010356	
R162	010141	RES	METAL	10 K	.25%	1/4 W	PYROFILM	PME6010	
R163	000912	RES	CARBON	9.1 K	5%	1/4 W1	OHMITE	RC07GF912J	
R164	020050	RES	WW	9.0 K	.01%	1/4 W1	KELVIN	EP-21	
R165	021395	RES	WW	1 K	.01%	1/4 W	JORDAN	J-12	

Assembly Ratio Option 403333

REF DESIG.	PART NO.	DESCRIPTION				
R82	000515	RES	CARBON	5.1M 5% 1/4W	OHMITE	RC07GF515J
R83	000106	RES	CARBON	10M 5% 1/4W1	OHMITE	RC07GF106J
R84	040092	RES	VARI	20K	SPECTRO	50-3-1-2 03

PCB Assembly BCD Output 403323

REF DESIG.	PART NO.	DESCRIPTION						
C01	110071	CAP	ELECT	.1 MFD 35V 10%			KEMET	K1W35K
C02	110070	CAP	ELECT	22 MFD 6V 10%			KEMET	K22W6K
C03	110071	CAP	ELECT	.1 MFD 35V 10%			KEMET	K1W35K
CR01	211083	DIODE	SILICO	018		1	DANA	211083
CR02	211083	DIODE	SILICO	018		1	DANA	211083
CR03	220031	DIODE	SILICO	ZENER 1/4M3.3AZ5			MOTOROLA	1/4M3.3AZ5
R01	000202	RES	CARBON	2K	5%	1/4W1	OHMITE	RC07GF202J
R02	000362	RES	CARBON	3.6K	5%	1/4W1	OHMITE	RC07GF362J
R03	000102	RES	CARBON	1K	5%	1/4W1	OHMITE	RC07GF102J
R04	000102	RES	CARBON	1K	5%	1/4W1	OHMITE	RC07GF102J
R05	000241	RES	CARBON	240 OHM	5%	1/4W1	OHMITE	RC07GF241J
M01	230024	INTEGRATED CIRCUIT MC893P					MOTOROLA	MC893P
M02	230019	INTEGRATED CIRCUIT MC824P					MOTOROLA	MC824P
M03	230061	INTEGRATED CIRCUIT MC9818P					MOTOROLA	MC9818P
M04	230061	INTEGRATED CIRCUIT MC9818P					MOTOROLA	MC9818P

PARTS LIST

ASSEMBLY 403081 and 403225 PCB ASSEMBLY, Power Supply A

REF. DESIG.	PART NO.	DESCRIPTION						
CR01	210004	DIODE SILICO	SD4			DIODES IN SD4		
CR02	210004	DIODE SILICO	SD4			DIODES IN SD4		
CR03	210004	DIODE SILICO	SD4			DIODES IN SD4		
CR04	210004	DIODE SILICO	SD4			DIODES IN SD4		
CR05	210004	DIODE SILICO	SD4			DIODES IN SD4		
CR06	210004	DIODE SILICO	SD4			DIODES IN SD4		
CR07	210014	DIODE SILICO	023			DANA	210014	
CR08	210014	DIODE SILICO	023			DANA	210014	
CR09	210014	DIODE SILICO	023			DANA	210014	
CR10	210014	DIODE SILICO	023			DANA	210014	
CR11	221177	DIODE SILICO ZENER			1/4 W1	MOTOROLA	M.2.4A25	
CR12	220035	DIODE ZENER	IN966B			MOTOROLA	IN966B	
CR13	220035	DIODE ZENER	IN966B			MOTOROLA	IN966B	
C02	121088	CAP MYLAR	.01 MFD	100 V	10%	CDE	WMF1S1	
C03	121088	CAP MYLAR	.01 MFD	100 V	10%	CDE	WMF1S1	
C04	120072	CAP MYLAR	.01 MFD	600 V	10%	CDE	WMF651	
C05	110067	CAP ELECT	2000 MFD	35 V	20%	DUCATI	2000-35	
C06	110107	CAP ELECT	4000 MFD	15 V		DUCATI	4000DX1512-10	
C07	110065	CAP ELECT	20 MFD	350 V	20%	DUCATI	20-350	
C08	110067	CAP ELECT	2000 MFD	35 V	20%	DUCATI	2000-35	
C09	120003	CAP MYLAR	.1 MFD	100 V	10%1	CDE	WMF1P1	
C10	120003	CAP MYLAR	.1 MFD	100 V	10%1	CDE	WMF1P1	
C11	110066	CAP ELECT	15 MFD	200 V	20%	DUCATI	15-200	
C12	110070	CAP ELECT	22 MFD	6 V	10%	KEMET	K22W6K	
C13	100017	CAP CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10	
C14	110043	CAP ELECT	25 MFD	25 V	20%	DUCATI	25-25	
C15	110043	CAP ELECT	25 MFD	25 V	20%	DUCATI	25-25	
C16	101174	CAP CERAM	.001 MFD	500 V	10%1	AEROVOX	SCD3X5F	
C17	101174	CAP CERAM	.001 MFD	500 V	10%1	AEROVOX	SCD3X5F	
C18	110077	CAP ELECT	1000 MFD	15 V		AMPEREX	C437PR/E1000	
C19	120019	CAP MYLAR	.47 MFD	100 V	10%	CDE	WMF1P47	
Q01	200043	TRANS SILICO NPN	2N3565			FAIRCHILD	2N3565	
Q02	200035	TRANS SILICO NPN	014			DANA	200035	
Q03	200030	TRANS SILICO NPN	40250			RCA	40250	
Q04	200035	TRANS SILICO NPN	014			DANA	200035	
Q05	200052	TRANS SILICO PNP	009			DANA	200052	
R01	000224	RES CARBON	220 K	5%	1/4 W1	OHMITE	RC07GF224J	
R02	030014	RES CARBON	220 K	5%	1 W	OHMITE	RC32GF224J	

PARTS LIST

ASSEMBLY 403081 and 403225 PCB ASSEMBLY, Power Supply A

REF. DESIG.	PART NO.	DESCRIPTION							
R03	000472	RES	CARBON	4.7 K	5%	1/4 W1	OHMITE	RC07GF472J	
R04	C00101	RES	CARBON	100 OHM	5%	1/4 W1	OHMITE	RC07GF101J	
R05	C00102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J	
R06	CCC202	RES	CARBON	2 K	5%	1/4 W1	OHMITE	RC07GF202J	
R07	C00202	RES	CARBON	2 K	5%	1/4 W1	OHMITE	RC07GF202J	
R08	C40063	RES	VARI	500 OHM	10%	1.5 W	CTS	110	
R09	0C0511	RES	CARBON	510 OHM	5%	1/4 W1	OHMITE	RC07GF511J	
R10	0C0151	RES	CARBON	150 OHM	5%	1/4 W1	OHMITE	RC07GF151J	
R11	C00151	RES	CARBON	150 OHM	5%	1/4 W1	OHMITE	RC07GF151J	
R12	030007	RES	CARBON	150 OHM	5%	3 W	OHMITE	4396	
R13	030007	RES	CARBON	150 OHM	5%	3 W	OHMITE	4396	

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(201) 423-3039

SOUTH CAROLINA
(800) 327-0853

SOUTH DAKOTA
(312) 932-4922

TENNESSEE
(800) 327-0853

TEXAS
Austin
(512) 451-5174
Dallas
(214) 661-0300
Houston
(713) 780-2511
San Antonio
(512) 342-3031

UTAH
(714) 859-8999

VERMONT
(315) 475-1500

VIRGINIA
(703) 941-0525

WASHINGTON
(503) 241-8624

WEST VIRGINIA
Eastern
(703) 941-0525
Western
(800) RAC-DANA

WISCONSIN
(800) RAC-DANA

WYOMING
(714) 859-8999

CANADA
Ontario
(416) 671-3920 or
(613) 726-8888
Quebec
(514) 336-0392
British Columbia
(604) 430-1410

7/84

RACAL-DANA Instruments Inc.

U. S. AND CANADIAN SERVICE CENTERS

FACTORY SERVICE

A

RACAL-DANA INSTRUMENTS INC.
4 Goodyear Street
Irvine, California 92714
Telephone: (714) 859-8999

PRODUCT SERVICE TWX 910-595-1136

REGIONAL SERVICE CENTER

B

RACAL-DANA INSTRUMENTS INC.
5101 "D" Blacklick Road
Annandale, Virginia 22003
Telephone: (703) 941-0525

INTERNATIONAL SERVICE CENTERS

RACAL-DANA INSTRUMENTS LTD.

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Berkshire SL4 1SB, United Kingdom
Telephone: Windsor (07535) 69811, TLX: 847013

RACAL-DANA INSTRUMENTS S.A.

18 Avenue Dutartre, 78150 Le Chesnay, France
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RACAL-DANA INSTRUMENTS GmbH.

Hermannstrasse 29, D-6078 Neu Isenburg,
Federal Republic of Germany
Telephone: 06102-2861/2, TLX: 412896

RACAL-DANA INSTRUMENTS ITALIA srl.

20161 Milano, Via Angeloni 8, Italy
Telephone: (02) 6459558/6468189, TLX: 315697

REPAIR REQUEST FORM

To allow us to better understand your repair requests, we suggest you use the following outline and include a copy with your instrument to be sent to your local Racal-Dana repair facility.

Model Number _____ Options _____ Date _____

Serial Number _____ P. O.# _____

Company Name _____

Address _____

City _____ State _____ Zip Code _____

Contact _____ Phone Number _____

1. Describe, in detail, the problem and symptoms you are having.

_____

_____

2. If you are using your unit on the bus, please list the program strings used and the controller type, if possible.

_____

_____

3. List all input levels, and frequencies this failure occurs.

_____

_____

4. Indicate any repair work previously performed.

_____

_____

5. Please give any additional information you feel would be beneficial in facilitating a faster repair time. (I. E., modifications, etc.)

_____

_____

MP MASTER
MA30583